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PLANT AND ENTOMOLOGICAL SCIENCES
I CROP PRODUCTION

ANNUAL REPORT OF THE
NATIONAL RESEARCH PROGRAMS
1976

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FOREWORD

I Crop Production

Research under Program Element 677, Crop Production Efficiency Research has been divided into two parts. Part I includes research under 15 National Research Programs (NRP) in Crop Production and Part II deals with research under 9 Crop Protection NRP's. Each part also includes 2 Special Research Programs.

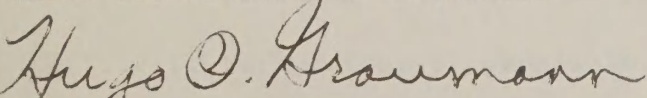
Research is conducted to improve plant productivity through improved varieties of food, feed, fiber, forage, florist and nursery crops, and turf to develop new crop resources and to develop improved crop production practices. Current emphasis is on research to develop new genetic stocks and varieties, increase yields and quality of crops, improve mechanization and crop production practices and to alleviate the effects of adverse environmental conditions through hardier plants.

New multidisciplinary concepts for increasing our productive capacity have been initiated. Special emphasis has been placed on improving basic photosynthetic processes in plants, natural nitrogen-fixing processes in soils and plants, better use-efficiency of both renewable and non-renewable energy resources, and control of plant growth and development.

The research workers in the Plant and Entomological Sciences publish the results of their investigations in the open literature as quickly as sound judgment warrants. The purpose of this report, however, is to provide for those interested in the results of this work, a brief overview of the scope of the activities and examples of recent findings, some of which still have not been released by publication. No attempt is made at completeness.

This report outlines the research responsible to the Plant and Entomological Sciences Staff and provides a brief description of recent accomplishments at the various locations throughout the United States. The report is organized by ARS National Research Programs, each of which describes a separate subject matter area. The ARS National Research Programs are subdivided into Technological Objectives which more specifically describe the objectives of each area of research.

Readers who have comment or inquiries are invited to contact either the National Program Staff or, more appropriately, scientists at the locations where the research is conducted.



H. O. Graumann
Assistant Administrator
Plant and Entomological Sciences

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TABLE OF CONTENTS

National Research Program (NRP)

NRP 20010	<u>Breeding and Production--Fruits, Nuts, and Specialty Crops</u>	Page
T01	Develop new and improved varieties of fruits, nuts, speciality crops; Examples of Progress for T01 (Breeding).....	1
T02	Develop new and improved cultural and management practices for fruits, nuts, and specialty crops; Examples of Progress for T02 (Cultural Studies).....	11
NRP 20020	<u>Breeding and Production--Vegetables</u>	
	Germplasm Development.....	28
	Variety Development.....	35
	Genetics and Breeding.....	39
	Pathology.....	40
	Physiology and Cultures.....	43
NRP 20030	<u>Breeding and Production--Florist and Nursery Crops</u>	
	Germplasm Development.....	47
	Variety Development.....	48
	Distribution of Plant Stocks.....	48
	Physiology.....	48
NRP 20040	<u>Breeding and Production--Corn, Sorghum and Millets</u>	
	Selected Examples of Progress	
	Corn.....	52
	Sorghum.....	58
	Millet.....	59
	Releases of Germplasm Developments - Appendix I.....	60

TABLE OF CONTENTS

NRP 20050	Breeding and Production--Small Grains (Wheat, Oats, Barley, Rice, Rye, Triticale, Wild Rice, Buckwheat)	Page
	Examples of Progress	
	Small Grains.....	68
	Wheat.....	69
	Oats.....	74
	Barley.....	76
	Rice.....	77
	Small Grain Varieties Released in 1975-76 - Appendix 1.....	79
	Small Grain Germplasm Released in 1975-76 - Appendix 2.....	81
NRP 20060	<u>Breeding and Production--Cotton</u>	
	T01 New and improved genetic populations, breeding lines, and varieties of cotton.....	88
	T02 New and improved cultural and management practices....	91
NRP 20070	<u>Breeding and Production--Tobacco</u>	
	Quality Improvement.....	100
	Homogenized Leaf Curing.....	101
	Chemical Ripening.....	102
	Developing Disease Resistant Varieties.....	103
	Seedling Production.....	104
	Sucker Control Chemicals.....	104
NRP 20080	<u>Breeding and Production--Soybeans, Peanuts, and Other Oilseed Crops</u>	
	Progress Reports by Species, TO, and Locations.....	106
	Soybeans.....	106
	Peanuts.....	119

TABLE OF CONTENTS

	Page
Flax.....	122
Sunflowers.....	124
Safflowers.....	128
Guar.....	130
 NRP 20090 <u>Breeding and Production--Sugar Crops</u>	
T01 Develop new and improved breeding lines and varieties.....	143
Sugarcane.....	143
Sugarbeet.....	146
Sweet Sorghum.....	152
T02 Develop new and improved cultural and management practices.....	153
Sugarcane.....	153
Sugarbeets.....	155
Sweet Sorghum.....	157
 NRP 20100 <u>Breeding and Production--Forage Crops for Hay Pastures and Other Uses, Including Turf</u>	
T01 New and improved genetic populations, breeding lines, and cultivars of forage crops.....	160
T02 New and improved cultural and management practices that increase forage crop yields, etc.....	172
T03 New and improved cultural and management practices that increase forage crop and turfgrass seed yield, etc.....	178
T04 Turfgrass cultivars and genetic populations.....	180
T05 Improved cultural and management practices for turfgrasses.....	182
Germplasm Releases.....	184

TABLE OF CONTENTS

NRP	20110	<u>Improved Vegetation and Management Practices for Range</u>	Page
	T01	Acquire, describe, and evaluate new germplasm.....	196
	T02	Develop range improvement practices for increasing productivity of rangeland.....	198
	T03	Develop grazing (forage-livestock) management systems.....	201
		Germplasm Releases.....	203
NRP	20160	<u>Plant Germplasm (Intorduction, Evaluation, and Maintenance)</u>	
	T01	Expanded collections and improved maintenance, evaluation, and distribution of plant germplasm.....	208
	T02	New and improved knowledge of the chemical, biological, and agronomic potentials of selected plant species as new crops.....	212
	T03	Increased understanding of the taxonomic relationships, geographical and ecological distribution, and centers of diversity of crop plants.....	213
NRP	20170	<u>Physiological and Biochemical Technology to Improve Crop Production</u>	
	T01	Improve biological conversion of solar energy.....	216
	T02	Improve nitrogen fixation efficiency of bacteria-plant associations and develop nitrogen-fixing capabilities in crops lacking this capability.....	218
	T03	Develop new and improved cell and tissue culture technology for plant improvement through increased genetic diversity and rapid vegetative propagation...	219
	T04	Develop technology for improving the absorption, translocation, and utilization of nutrients and water to increase crop production efficiency.....	222
	T05	Improve technology for better crop production under environmental stress.....	222

TABLE OF CONTENTS

		Page
	T06 Develop technology for control and regulation of biochemical, physical, and morphological process of plants.....	226
	T07 Develop technology for reducing damage to crop plants from air pollution.....	229
NRP 20180	<u>Crop Pollination, Bees and Honey</u>	
	T01 Improve management of honey bees for most effective crop pollination and honey production.....	237
	T02 Improve methods of protecting bees from pesticides, diseases, pests, and pollution.....	237
	T03 Determine pollination requirements of economically important crops.....	238
	T04 Identify and study biology of wild bee pollinators and improve methods of using wild bees for crop pollination.....	238
	T05 Improve honey bee breeding and rearing.....	238
	T06 Develop methods of detecting honey adulteration.....	239
NRP 20190	<u>Improved Methods and Equipment for Production of Field, Fiber, and Horticultural Crops</u>	
	T01 To develop improved equipment for harvesting crops...	243
	T02 To develop improved equipment and techniques for farm handling, cleaning, drying and processing of harvested crops.....	254
	T03 To develop improved equipment and techniques for tilling, planting, transplanting, fertilizing, and cultivating.....	261
	T04 To develop equipment and facilities to control environmental factors that affect crop production in greenhouses, in plant growth rooms and in the field.....	268
SRP	<u>Production and Control of Narcotic Plants.....</u>	272
SRP	<u>Genetic Vulnerability of Crops</u>	277

NRP Annual Report
FY 1976

NRP 20010 Breeding and Production--Fruits, Nuts, and Specialty Crops

NPS Contact: H. J. Brooks

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This ARS National Research Program involves research on breeding and production of fruit, nut, and specialty crops to develop new and improved genetic and cultural methods that will result in lowering costs of these crops to consumers and increasing efficiency of production for growers, small acreage farmers, and homeowners. Geneticists, horticulturists, plant physiologists, and plant pathologists work as a team to evaluate and improve fruit, nut, and specialty crops and cultural methods. This research is cooperative with scientists of State agricultural experiment stations. This research is conducted on 26 different crops at 17 locations in 13 States. These crops are grown on 3.75 million acres with an aggregate farm value of 3.7 billion dollars.

TECHNOLOGICAL OBJECTIVES

This research program has two primary technological objectives, as follows:

- 1 Develop new and improved varieties of fruits, nuts, and specialty crops that combine improved yield potentials; quality characteristics; better resistance to pests; tolerance to environmental stress; and adaptation to mechanical culture, harvesting, and handling.
- 2 Develop new and improved cultural and management practices for fruits, nuts, and specialty crops that increase yield, minimize production losses, improve quality, and conserve use of natural resources.

EXAMPLES OF PROGRESS FOR TECHNOLOGICAL OBJECTIVE 1 (BREEDING)

Apple Breeding

Fifteen new selections were made in the apple breeding program which serves the Southern United States. About 6200 of the original 11,000 seedlings at the Blairsville, Georgia, Mountain Experiment Station

have now been evaluated and discarded. No new plantings are planned at Blairsville but new seedlings are being planted at Byron, Georgia. Trees of the Mollie's Delicious apple variety were irradiated in an attempt to produce advantageous mutants. The optimum dosage of radiation is now known to fall between 7 and 9 Krads. (Byron, GA)

Pear Breeding

This program is cooperative between Wooster, Ohio and Beltsville, Maryland. Over 75 crosses were made at Beltsville but late spring frosts prevented fruit set. Late spring frosts at Wooster precluded any crosses as the blossoms were severely injured. About 20,000 seedlings were started in the greenhouse. 10,000 seedlings were screened for fire blight. 1000 seedlings of selected parentage were planted for a study of pear psylla resistance. 1000 seedlings of selected parentage were planted for a study of *Fabraea* leaf spot. 3000 seedlings were planted in 1976 for fruit and tree evaluation. As no seed was obtained in 1976, 5000 seedlings were planted in a nursery for planting in 1977. Fruit evaluations for 2975 seedlings and 137 cultivars were made at Wooster. A total of 212 seedlings screened for fire blight were planted at Wooster. A computerized inventory of all cultivars or selections used as parents was completed. (Wooster, OH)

A computerized inventory of all crosses made since 1942 and the results obtained from the crosses was completed. Fruit evaluation forms were modified and a mark-sense form designed to eliminate key punching. About 10,000 seedlings are growing at Wooster. The spread of fire blight in 1976 was very severe and should result in a good screening for fire blight resistance. A marked contrast exists in the variety orchard as the named varieties show very severe fire blight whereas the USDA selections show very little. Data were taken on fire blight and pollen sterility on all trees. (Wooster, OH)

The pear breeding program has been widened to include overall resistance of the plant material to *Fabraea* leaf spot and pear psylla along with blight resistance. A total of 30,000 pollinations (82 crosses) were made in the spring, resulting in 11,000 seedlings (45 progenies) in the greenhouse. About one-half of these plus 1600 seedlings from Wooster and 4200 from the program at Rutgers University were screened for blight. An average of 10% of the seedlings were resistant. In 1975, there were 34 days between the earliest and latest blooming pear clones. In interspecific hybrids, two generations were needed to bring the bloom time of the progeny to that of the later blooming parent. No seedling in a progeny flowered later than the later blooming parent. (Beltsville, MD)

Evidence was obtained for the existence in Pyrus communis of a dominant gene Se causing dramatic sensitivity to the blight organism. Thirteen cultivars and four selections were found to be Sese and four cultivars and three selections to be sese. This allows breeders to exclude cultivars with Sese from the breeding program but use those with sese for resistance. An analysis was made for correlation between fire blight resistance and fruit quality of 2600 seedlings in 395 crosses. Phenotypic correlation between blight resistance and the quality factors were all close to zero. Selection for fire blight resistance and high fruit quality appears feasible and susceptible seedlings may be discarded with impunity. (Beltsville, MD)

Stone Fruit Breeding

Approximately 2000 peach and nectarine, 3500 apricot, and 4500 plum seedlings were planted and 1000 peach and nectarine, 1500 apricot, and 2500 plum seedlings fruited for the first time and were evaluated in 1976. These seedlings were the result of crosses made to develop stone fruit varieties which have improved yield, quality, and shipping characteristics and ripen over the entire season. Fourteen peaches, 24 nectarines, 22 plums, and 17 apricots were selected and saved after the 1975 fruiting season for further observation. Five peach, 12 nectarine, 12 plum, and 1 apricot selections are being tested commercially and appear promising as potential varieties. (Fresno, CA)

Five redleafed nematode-resistant rootstocks for stone fruits are being evaluated cooperatively with the University of California Experiment Station at Kearney. The redleafed rootstocks have a great advantage over greenleafed rootstocks for the nursery industry. (Fresno, CA)

In the continuing effort to develop new stone fruits for the Southeastern States, new peach and nectarine crosses were made. Resistance to the bacterial spot disease has been identified and progress has been made in combining this characteristic with fruit quality and yield. The new Sunbrite peach variety was released. Four peach selections were rated as promising for mechanical harvesting. The entire plum crop was lost to a late frost and plum crosses planned for 1976 will be delayed until 1977. A new technique has been developed for inoculating and screening peach and nectarine seedlings for resistance to the bacterial spot disease. (Byron, GA)

Controlled hybridization in apricot, European plum, peach, and sweet cherry was carried out. Approximately 4000 seedlings were germinated and planted. From fruiting progenies, 94 peach, 8 apricot, 16 plum, and 17 sweet cherry seedlings were selected and propagated for further evaluation. Evaluation of fruiting selections in advanced test plantings was continued. Pollination tests were made to determine the length of the receptivity period for stone fruit pistils. Additional haploid peach and nectarine seedlings were obtained and haploids

converted to diploids by colchicine treatment for use in developing seed propagated varieties and F₁ hybrids. Selfed seed of four homozygous lines was obtained. (Prosser, WA)

A progeny of about 200 genetic dwarf peach seedlings was planted to establish inheritance of the dwarf character. The period of bloom occurred about 3 weeks early and late spring frosts killed nearly all fruit from controlled pollinations. Two advanced peach selections were found superior to other selections and are being considered for commercial introduction. (Beltsville, MD)

Strawberry Breeding

Fifty-seven strawberry clones were machine harvested, mechanically capped, and processed and two selections were outstanding in production of ripe usable fruit and good processing quality. A portable model capper, constructed by Oregon State University Agricultural Engineering Department was capable of distinguishing easy capping types and can be used for screening seedlings in the field. Grower interest increased in this program to develop varieties for machine harvest and the industry made plans to establish commercial trial plantings of promising selections. (Corvallis, OR)

From 40,204 seedlings screened in the greenhouse for resistance to red stele disease, 14,980 were resistant and transplanted to the field for fruiting. From 5526 seedlings fruiting in 1976, 111 new selections were made. Selections made last year were evaluated. Screening of several advanced selections for resistance to verticillium wilt showed that one of the everbearing selections was highly resistant. From 4039 seedlings of everbearing parentage, 54 everbearers were selected for further testing. (Beltsville, MD)

A severe outbreak of anthracnose occurred on strawberries at the Clinton station in North Carolina. About 1% of the 7500 seedlings showed resistance. Eleven of 135 selections appeared to be highly resistance. Six of the resistant selections were used in 29 crosses to produce seedlings to be screened against anthracnose. A cooperative program for breeding anthracnose resistant strawberries was initiated by USDA, North Carolina, Florida, and Louisiana. Resistant clones from Florida and Louisiana were also used in the crosses for anthracnose resistance. (Beltsville, MD)

Blueberry Breeding

One-year blueberry seedlings from crosses at Beltsville were sent to Mississippi, Georgia, North Carolina, and New Jersey. Most of the seedlings were interspecific hybrids and were either tetraploid or hexaploid. These populations show promise at all locations and selections at each location have been propagated. One selection, MeUS 32, was released jointly by the USDA and Maine as the Patriot. It is the first highbush cultivar known to be resistant to the root rot fungus caused by Phytophthora cinnamomi. (Beltsville, MD)

About 1500 blueberry seedlings from 15 crosses were planted in February 1976. Thirty-two plants were selected for further evaluation from the 1974 and 1975 seedling nurseries. Criteria for selections included fruit size, color, taste, firmness, ripening data, yield, and plant growth vigor. Rooted cuttings from selections made in 1975 were planted in an observation plot. (Poplarville, MS)

Seedlings from six different highbush blueberry variety crosses were evaluated for mummy berry fungus resistance. The Berkeley X Collins cross produced the highest percentage of seedlings with high resistance. (New Brunswick, NJ)

Raspberry Breeding

Early fall-cropping raspberry selections produced ripe fruit from primocanes as early as July. The fruit still needs firmness and flavor in most selections but good progress is being made toward developing self-supporting varieties that will not require trellising. (Corvallis, OR)

Blackberry Breeding

Additional crosses among tetraploid, thornless blackberry clones produced sufficient seed to give 1000 seedlings. The seedlings are being sent to Wooster for field planting where they will be screened for winter hardiness. Additional crosses were made among erect diploid blackberry clones having genes for thornlessness. These seeds will produce the seedlings for next year. (Beltsville, MD)

Grape Breeding

From about 14,000 seed of 58 progenies of the 1974 grape crosses, 11,400 seedlings were screened for black rot resistance. Six crosses

were made in cooperation with North Carolina State University and 1176 resistant out of 2895 seedlings were sent there for evaluation. Of the remaining progenies, 2580 resistant seedlings went to the nursery and of these 1047 were moved to the vineyard in 1976. Flowering data were taken from the 1971 and 1972 progenies and pollen was collected for F₂ backcrosses to *vinifera* to see if resistance can be carried through a second generation. Twenty-one progenies of the 1975 crosses comprising 2213 seedlings are being screened. Preliminary results showed Vitis Berlandieri varies greatly in levels of transmissible resistance to black rot. Crosses underway in 1976 include progenies cooperative with the Florida grape program. (Beltsville, MD)

Approximately 5000 grape seedlings representing seed from 22 crosses were planted. Approximately 6000 seedlings fruited and were evaluated for the first time of which 47 were selected and saved after the 1975 fruiting season for further evaluation. Ten outstanding selections were grafted and planted in the second test plot. One large white seedless table grape is being tested commercially and appears promising as a potential variety. Evaluation of existing nematode and phylloxera resistant rootstock selections was continued but no new tests were established. Tests of seedlings for improved raisin varieties were continued. (Fresno, CA)

Citrus Breeding

About 3000 seeds from crosses designed to develop clones resistant to Phytophthora, burrowing nematode, cold, and drought were harvested and planted. Several clones of Microcitrus were isolated as highly resistant to burrowing nematode. Over 8000 nucellar seedlings of Carrizo and Troyer citrange were screened for spontaneous polyploid frequency. Two hundred and seventy-nine citrus selections were screened for Phytophthora parasitica tolerance and 52 of the best were retested. A plant collection trip was made by Dr. Don Hutchison to Australia and New Guinea. Some 37 seed samples of Microcitrus species and 36 seed samples of other Citrus or citrus relatives were collected to be used in the rootstock-variety breeding program. A promising tangerine hybrid was found to be self-incompatible but Temple, Nova, Orlando, or Robinson could be used as a pollinator. (Orlando, FL)

Young trees of selected Eremocitrus hybrids with Valencia orange, Nagami kumquat, sour orange, and Koethen sweet orange were found more cold hardy than the citrus parent, while Eremocitrus was the most hardy.

Seedling hybrids of pummelo X Poncirus Trifoliata were screened for cold hardiness and many were very cold hardy. A growth chamber test was developed to measure relative dormancy of citrus seedlings. (Orlando, FL)

Three rootstock tests with a variety of rootstocks were planted at La Belle and Merritt Island for evaluation of general adaptability, fruit quality, production, and disease resistance. A rootstock-exocortis virus interaction test was planted at Leesburg and two rootstock tests with 20 rootstocks each were planted at Dade City and Clermont for general horticultural evaluation, particularly cold hardiness. (Orlando, FL)

Large number of citrus hybrids were evaluated for fruit quality and other characteristics. Six hybrids were selected for second test on commercial rootstocks and for breeding stock. About 1 acre of the Brawley planting has been planted with a collection of the best citrus breeding stock developed at Indio. This provides an alternate germplasm repository. The Brawley hybrid block was partially replanted with 1100 hybrids involving crosses among oranges, grapefruit, and mandarins. Another 1000 hybrids have been grown at Indio for later transplanting to Brawley. Seedlings of 12 citrus crosses for dessert fruits are being grown for 1977 plantings. In the citrus rootstock breeding program, 700 Phytophthora-tolerant hybrids were planted in 1975 and 700 in 1976. These seedlings are the survivors from rigorous inoculation tests. Many hybrid seedlings of this series planted in 1971 and 1972 are beginning to fruit. Their progeny will be available for testing and study in 1977. A few more crosses were made to produce Phytophthora-tolerant hybrid rootstocks. (Indio, CA)

Breeding Subtropical Fruits

Fifteen cultivars and breeding lines of Solo papaya were evaluated with the St. Croix variety for resistance to the St. Croix papaya decline disease. The greatest tolerance to the disease has been shown by some individual trees of the St. Croix variety. Seeds from three single tree selections have been planted for further studies. (St. Croix, Virgin Islands)

Approximately 7000 papaya seeds were harvested from self and cross-pollinations directed toward improved quality and virus tolerance. Successful self-pollinations of hermaphroditic plants demonstrated the feasibility of obtaining inbreds to concentrate genes for virus

tolerance. Successful self-pollinations of hermaphroditic plants demonstrated the feasibility of obtaining inbreds to concentrate genes for virus tolerance and to produce F₁ hybrid lines. Five new papaya introductions and 10 introductions of related Carica species (C. goudotiana, C. microcarpa, C. pubescens, C. quercifolia) were received. (Miami, FL)

One mango selection has ripened fruit earlier than any other mango cultivar for 3 consecutive years. Industry representatives consider fruit quality acceptable. Germplasm distributions of 87 mangos included 3 cultivars of 28 new introductions introduced from Thailand in 1973. Other distributions included 63 carambolas, 60 avocados, 54 passion fruit, 18 lychees, 15 longans, 29 mulberry, and over 100 other miscellaneous subtropical fruits. The passion fruit distributions were mainly of a self-compatible cultivar expected to fruit in isolation with no need for cross-pollination. An exotic Indonesian fig (Ficus septica) set large quantities of viable seeds because of activities of a fig wasp. (Miami, FL)

Date Breeding

Progeny of the 1970 crosses have progressed well. In 1975, 159 females (37% of the total population) fruited and many plants were evaluated for the second time. Among the 1971 progeny, nearly 400 females fruited in 1975. These represented 25% of the total progeny and are hypothetically equivalent to about 50% of the females. Several hundred male and female palms were eliminated to accommodate those retained for further study. Some males of special interest are retained for metaxenia studies or for establishment of back-crossed lines. Limited data suggest that Empress, Khadrawy, and Thoory, when used as female parents, and Khadrawy BC₃, Tadala BC₁, and Thoory BC₃, when used as male parents, may induce early flowering in a high proportion of the crosses in which they occur. About 300 hybrid seedlings from 1974 crosses were planted in the field (Indio, CA)

Pecan Breeding

Forty selections from cross-bred seedlings were propagated for further trial as potential varieties from seedlings fruiting in 1975. Additional testing sites for advanced selections were established. Seven hundred and fifteen seedlings resulted from 17 crosses made in 1974 between selected parents. Six hundred and thirty-five hybrid

seed were harvested from 15 controlled crosses made in 1975 and planted in the greenhouse April 1976. Numerous controlled crosses were made in 1976 using scab resistant parental material. Kiowa, a selection of a cross between Mahan X Odom, was released to nurserymen and growers in April 1976. The variety is highly precocious, prolific, exhibits large nut size for in-shell trade, and shells out a high percentage of excellent flavored kernels. Controlled pollination studies indicate that excessive pollen applied may result in reduced nut set. (Brownwood, TX)

Filbert Breeding

Seed collections from Corylus columna trees grown in filbert (C. avellana) orchards have been made, germinated, and lined out in nursery rows for selection. Apparent interspecific hybrids were placed in layerage for production of self-rooted trees. Layered rootstock selections are top-worked with a common filbert cultivar ('Ennis'). This year, 49 trees were available to be planted off-station with a cooperating grower. Efforts to make interspecific Corylus crosses under controlled conditions have all failed to date. (Corvallis, OR)

Hop Breeding

Two new hop varieties, Columbia and Willamette, were released to growers March 25, 1976. Both varieties are triploids, genetically sterile, and produce seedless hops. Columbia has higher alpha acids (8-9%), good storage stability, and European flavor characteristics. Columbia is highly suited to extract and export. Willamette is milder (5-7% alpha) and is suitable to replace imported hops. An additional triploid selection was advanced to commercial scale testing. Its main advantage over Columbia and Willamette is early maturity. (Corvallis, OR)

About 200 male and 600 female seedlings from the 1973 nursery were evaluated for quality and about 2500 seedlings were evaluated for mildew resistance. Very high lupulin and alpha acids content were found in a large number of seedlings, many of which also had good mildew resistance. Three mildew-resistant, cluster-type selections produced good yields and alpha acid levels in 1975. Results from pilot brewing and organoleptic evaluation by interested brewers and dealers indicated that all three selections would be acceptable as cluster-types. Crosses for studying the inheritance of alpha acids were made between a male having zero alpha and three females also having zero alpha. (Corvallis, OR)

Thirty-seven high-alpha acids selections were planted at the Prosser, WA research station and in an evaluation nursery at Yakima, WA. At Corvallis, the same selections were evaluated ~~as~~ two-year-olds. Yield levels frequently exceeded 2000 lbs. per acre with alpha acids content between 11 and 14%. These same selections are being evaluated for virus content and reaction by Washington State cooperators. (Corvallis, OR)

Several triploid male lines were evaluated for flowering compatibility with commercial hop varieties. One line was selected for advancement and future release as a pollinator male to increase cone and soft resin production without seed set. (Prosser, WA)

Mint Breeding

About 150 selections of Scotch spearmint derived from irradiated rhizomes have survived three inoculations with Verticillium wilt disease. About 100 of the best selections will be field-tested in 1976. Rhizomes of Todd's Mitcham peppermint containing about 100,000 buds were irradiated at 7000 radiation absorbed dosage units to induce mutations that would increase yields. Plants derived from the irradiated material are being evaluated for branching pattern, canopy structure, leaf numbers, and oil gland numbers. (Corvallis, OR)

Germplasm Inventory and Preservation

A computerized listing of fruit and nut germplasm is nearly complete for the germplasm collections of North America. This list includes horticultural and genetic information of value to commercial growers and plant breeders. A national system of fruit and nut germplasm repositories has been planned by the National Plant Germplasm Committee. this plan calls for 12 different repository locations and cooperative funding and staffing by the Agricultural Research Service, the Cooperative State Research Service, and the State agricultural experiment stations. (Beltsville, MD)

EXAMPLES OF PROGRESS FOR TECHNOLOGICAL OBJECTIVE 2
(CULTURAL STUDIES)

Apple and Pear Viruses

A new apple bark disorder was successfully transmitted and 17 varieties of crab apples were inoculated to test their tolerance to various apple latent viruses. Pear varieties and species were inoculated for evaluation of a better virus indicator. In a preliminary test, 7 of 10 declining pear trees responded favorably to tetracycline treatment. This indicates pear decline still may be more of a problem than commonly thought. Homogenates of leaves or petals of virus infected apple and pear trees were inoculated into herbaceous hosts. An unidentified virus-like entity was successfully established in herbaceous hosts from apple trees infected with flat apple and apple mosaic and from pear trees infected with vein yellows and ring mosaic. (Wenatchee, WA)

Growth Regulators for Apples

Trials were continued on concentrate vs dilute application of chemical thinning agents. Concentrate rates of 80 gal/acre gave satisfactory results on Red Delicious but were inconsistent and generally inadequate for Golden Delicious. The best results on Golden Delicious were obtained when post bloom spray chemicals such as amide and sevin were combined and applied at a rate of 300 to 400 gal/acre. Return bloom on apples treated with ethephon and daminozide was excellent. In one block the ethephon caused excessive fruit thinning. Sprout control treatments on trunks and scaffold limbs were nearly 100% effective the first year and 75 to 90% effective the second and third growing season after application. (Wenatchee, WA)

Gibberellin acid and Benzyl Adenine sprays used to increase the length to diameter ratio and marketability of Delicious apples also caused some fruit abscission. More thinning occurred on Jonathan, Winesap, and Gold Delicious than on Red Delicious. A new growth regulator for controlling vegetative growth of fruit trees was effective at low rates (100 ppm) and did not cause damage to fruit of Granny Smith, Red Delicious, or Golden Delicious. It shows considerable promise for increasing branching and spur development of standard type bearing trees such as Granny Smith, Tydeman, Rome, and Delicious. (Wenatchee, WA)

Growth Regulators for Pears

Fruit set of 7 and 8-year-old Anjou pear trees was increased by spraying 4 or 6 weeks after bloom with daminozide (1000 ppm) plus ethephon (250 ppm), ethephon (250 and 500 ppm), or chlormequat (1500 ppm). Chlormequat sprayed trees yielded 40 pounds more fruit per tree than comparable unsprayed trees. In addition to increasing fruit set, all the sprays reduced growth and the amount of pruning needed. Four new plots were established to compare 1000 and 1500 ppm chlormequat applied 5 weeks after bloom. Shoot growth in these plots was reduced about 20 percent by 1000 ppm and 30 percent by 1500 ppm. (Wenatchee, WA)

Growth Regulators for Peaches

Four chemicals for peach thinning were screened on a limb-unit basis; none were effective. A new ethylene-releasing chemical was applied on whole trees at 3 concentrations and 2 timings. Results suggest this chemical may be useful for thinning mid-or-late season varieties. Peaches exposed to atmospheric fluoride may develop the soft-suture disorder. Redhaven peaches were sprayed with TIBA, 2,4,5-Tp, and NaF to determine if the soft-suture disorder was a localized Ca deficiency. TIBA, which reduces Ca content of apples, did not cause soft-suture or lower Ca content of peaches. 2,4,5-Tp caused typical chlorinated phenoxy injury and raised and reddened sutures. Many fruits sprayed with NaF developed soft-suture. Fruits sprayed with both of the latter chemicals were lower in Ca at harvest. (Wenatchee, WA)

Apple Fertilization

Golden Delicious trees were fertilized with 2 rates of NH_4NO_3 and a foliar spray of urea, a herbicide program of paraquat+simazine and paraquat alone, and with and without CaCl_2 included in the cover sprays to determine if N fertilization could be reduced by half with the addition of urea or simazine in the program and still maintain consistent yield. Although the results thus far are premature and not complete, there were some trends indicating that sprays of CaCl_2 increased Ca in the leaves, simazine- CaCl_2 increased P in leaves, and that simazine or foliar urea-treated trees had increased N content in the leaves. Simazine treated plots had the best weed control. There was a higher correlation between 'green end' cull fruit and $\text{NO}_3\text{-N}$ in the soil than in leaf N in 1974. (Wenatchee, WA)

Time of application of calcium sprays to reduce bitter pit of apples has been arbitrary. The fruit Ca content of Golden Delicious apples was lowered by application of TIBA and then several series of calcium chloride sprays were applied at different times during the season. The effectiveness of the different series was based on the amount of pitting that developed in a stored sample and the actual Ca content of the fruit. Three applications of CaCl_2 mid to late June, July, and August reduced pitting to the level of controls and were more effective in reducing pitting than late season applications of Ca. However, late season applications of Ca increased fruit Ca content more than early season applications. (Wenatchee, WA)

Fruit Development Studies

Groups of six Golden Delicious apple trees were enclosed in mylar cages for 3-week intervals from bloom to 15 weeks after bloom. Enclosed trees were thus exposed to temperatures and humidities above ambient. Shoot growth of trees caged during the first two periods was less than uncaged trees. Fruit in cages always grew less than uncaged fruit but only caging during the second 3-week period from bloom seriously reduced harvest fruit size. Fruits of trees caged from bloom for 3 weeks were lower in Ca than fruits from uncaged trees. (Wenatchee, WA)

Cold Hardiness and Dormancy Research

Nearly 50 treatments of fall-applied chemical regulators were screened for early induction of cold hardiness on 1-year-old apple trees in a nursery and 6 and 9-year-old trees in the orchard. These resulted in significant differences in sorbitol content in the sap, degree of senescence and defoliation, percent of dry matter, amount of sap extracted, and conductivity. Respiration rates of the 1-year shoots were also recorded and preliminary results indicate that high rates of CO_2 are related to cold injury. There were partial trends indicating that CCC (Cycocel), CGA + NAA, Arest, and one experimental chemical may have induced some hardiness. There were also trends indicating that hardiness is related to sorbitol content but there were a few exceptions. Plant nutrition studies in mid-winter resulted in no apparent trends in hardiness as previously determined. (Wenatchee, WA)

Apple Tree Physiology Studies

Of three growth inhibitors tested, NA salt of 2,3:4,6 Bis-O-(1 methylethylidene) was toxic and systemic, ethyl 5-(4 chlorophenyl)-2H-tetrazol-2-ylacetate showed promise for forcing early branching, and Dyhydro-Diphengl-Oxothiin inhibited terminal growth with little branching potential for reducing shoot competition for Ca in cork spot control. $\text{ZnSO}_4 + \text{Ca}(\text{OH})_2$ sprays reduced cork spot more than CaCl_2 sprays. Combining dwarfing rootstock, early fruiting, SADH-ethephon sprays, summer pruning and reduced N can divert carbohydrate from vegetative to fruit production thus maintaining small, high-yielding trees. Aluminum ions in soil solution blocked the uptake of Ca and decreased shoot growth of apple seedlings. Aluminum effect was alleviated by increasing soil pH to 5.5 or above. At low pH, 4 ppm of aluminum appears to be toxic to the roots and affecting tree growth. (Beltsville, MD)

Apple and Pear Diseases

Comparison of ultra-low volume (0.5-1 gallon/acre) application of the fungicide Topsin with low volume (21 gallon/acre) and semi-low volume (53 gallon/acre) showed that the former gave as good control of apple scab as did the higher volumes. A laboratory technique using Penicillium expansum as the test organism was devised for studying the deposit of Topsin on leaves from field-sprayed trees. Relatively good correlation was obtained between the percent leaf area covered by the fungicide and scab control. This in turn was correlated with size of inhibition zones produced by the tree sprayed leaves when exposed in the laboratory to the fungus P. expansum. These tests indicate 35-50% saving of pesticide when applied in ultra-low volume. With such a system, additional savings such as less water usage, less energy expended during operation, and less cost of the equipment are indicated. It still has to be determined, however, if the system will work with commercial pesticides other than those related to Topsin.

Studies were completed on the relative virulence (pathogenicity) of streptomycin-resistant and streptomycin-susceptible Erwinia amylovora. In the greenhouse, Jonathan apple is more susceptible to infection by E. amylovora than Bartlett pear. Resistance of E. amylovora to streptomycin was associated with attenuation of virulence. (Beltsville, MD)

Stone Fruit Diseases in the East

A specially devised screening technique was used under greenhouse conditions to evaluate a large number of peach and apricot seedlings and cultivars for resistance to bacterial spot (Xanthomonas pruni). Several selections showing considerable resistance were transplanted to the field during late summer for comparison of the reactions in the field with those obtained under controlled conditions. Studies were continued on the ecological significance of phage-X. pruni interactions. Selections of X. pruni that survived treatments of excess pruni-phage are less virulent than the parent, phase-sensitive types. Continuing studies with a simple inoculation technique using Valsa leucostoma show that none of the more than 300 apricot and peach seedlings and cultivars evaluated show any significant degree of resistance. There is, however, a difference in virulence of the isolates tested. (Beltsville, MD)

Several hundred peach seedlings and selections were artificially inoculated with Xanthomonas pruni to determine field susceptibility to bacterial spot disease. A newly developed screening technique was also used on a small scale to test susceptibility of peach seedlings to X. pruni in the greenhouse. (Byron, GA)

Prunings removed from peach trees during winter were invaded by Botryosphaeria dothidea (gummosis) and covered with fruiting bodies within 4 to 6 weeks. Both pycnidia and perithecia were present on the prunings which may serve as a source of inoculum for spread of peach gummosis. (Byron, GA)

Stone Fruit Diseases in the West

Research has revealed that several Phytophthora spp are playing a major role in death of fruit trees in California. Phytophthora crown and root rot caused an estimated loss of 22% of all cherry trees in San Joaquin County during 1973-75. The most severe losses occurred in cherry trees on Mahaleb roots and in orchards with poorly drained soils. Preliminary results indicated marked difference in resistance of various rootstocks to these soil-borne pathogens. Mahaleb ~~was~~ more susceptible than Mazzard or Stocton Morello cherry rootstocks to three different Phytophthora spp. All tree rootstocks subjected to flood irrigation every 2 weeks developed severe root rot in artificially infested soils. However, only Mahaleb plants were affected with crown rot in infested soil irrigated only when water stress was observed on the rootstocks. These results strongly indicate that proper selection of rootstock and soil water management will minimize losses of cherry

trees caused by Phytophthora root and crown rot. In tests, Myrobolan 3J and Marianna 2624 were highly resistant, while Nemaguard, Lovell, and Almond were highly susceptible to P. syringae trunk canker disease which causes significant losses in stone fruit trees in California. (Davis, CA)

Phytophthora cambivora recovered from dead and dying prune trees caused severe trunk canker in artificially inoculated French Prune, whereas Mariann 2624 rootstock was resistant to this pathogen. Thus, use of proper rootstock and higher planting to avoid contact of scion with soil should prevent losses in prune trees caused by this pathogen. (Davis, CA)

Stone Fruit Virus Research

X-disease of peach may not be a predominate factor in the epidemiology of strawberry lethal decline as material from declining strawberries inoculated into peach failed to induce symptoms of X-disease and strawberries planted adjacent to peach trees infected with X-disease did not develop symptoms of lethal decline. Twist leaf has been observed spreading in two orchards in a manner indicative of a soil-borne virus. Soil samples revealed the presence of nematodes. Xiphinema americanum was found in soil from one orchard but not the other. Homogenates of leaves or petals of virus-infected cherry trees were inoculated into herbaceous hosts. An unidentified virus-like entity was successfully established in herbaceous hosts from cherry trees infected with twisted-leaf, short stem, mottle leaf, and little cherry. Field surveys and indexing indicate that little cherry may have spread into Northern Washington. (Wenatchee, WA)

The causal agent of cherry stem pitting was graft transmitted from diseased trees to healthy Mahaleb and Stocton Morello cherry rootstocks by both buds and root chips. Efficient transmission of the causal agent by buds suggest that spread of the cherry stem pitting, unlike that of peach stem pitting, can be effected by propagation as well as through infested soil. Use of budwood for propagation from known healthy trees will prevent dissemination of the stem pitting virus into areas and orchards free of this economically serious cherry disease. (Davis, CA)

Peach Rootstocks

Of several peach rootstocks tested for susceptibility to Pseudomonas syringae (bacterial canker) in the greenhouse, Siberian C was highly resistant; Nemaguard, Halford, and Elberta were intermediate; and Lovell was highly susceptible. (Byron, GA)

Peach Short Life Studies

After 3 years on a severe short life site, no peach trees have died where annual postplant fumigation or 12 lb hydrated lime plus preplant fumigation were used. Only 14% of trees died with lime alone. From 20 to 89% tree loss occurred where lower rates of lime were used with or without preplant fumigation. Hydrated lime at 12 lbs per tree site raised soil pH from 4.5 to 7.2 and greatly suppressed populations of Criconemoides xenoplax. Populations of fluorescent pseudomonads were much greater in limed or fumigated soils. (Byron, GA)

Aluminum Toxicity in Peaches

It was determined that aluminum toxicity in peach seedlings in nutrient solution appears to be associated with calcium deficiency and that increasing Ca concentration in solution does not correct the Ca deficiency or aluminum toxicity symptoms. There was little difference between seedlings from different cultivars. Diffusive resistance rates decreased with increasing aluminum concentration. The rates appeared to be more directly related to the decreased root system and its ability to supply water to the plant.

Strawberry Diseases

Strawberries sprayed the day before harvest with fungicides developed less post-harvest rot than unsprayed fruit. Unsprayed berries of Earliglow developed less decay after harvest than unsprayed berries of 11 cultivars. Fruit of Shuksan and Holiday showed some resistance to rot caused by Botrytis cinerea; Shuksan was highly susceptible to Rhizopus infection. (Beltsville, MD)

In order to eliminate Pallidosus virus from infected strawberry plants, over 550 runner tips were excised and cultured in agar. Some tips were also heat treated. About 30% of the tips that rooted appeared to be free of virus. The size of the tip appeared to be more important than the length of heat treatment. Tips of 30 cultivars were rooted in tubes for long term storage at 4°C. (Beltsville, MD)

Research showed for the first time that Phytophthora cactorum is the causal agent of vascular collapse disease that causes serious losses in certain commercial strawberry fields and nurseries. This disorder was previously attributed to Xanthomonas sp. Thus, control measures used for this disease were not effective. Observations indicated differential susceptibility of various strawberry cultivars to P. cactorum. The use of tolerant cultivars may minimize losses caused by this pathogen. (Davis, CA)

Blueberry Studies

Evaluated the irrigated varietal study established in 1975. Tifblue and Southland exhibited more vigorous growth than other varieties. Determined that nitrogen and potassium content in leaves increased lineally with increasing levels of these elements applied as fertilizer. Increase in phosphorus fertilization did not influence percent phosphorus in leaves. Nitrogen fertilization influenced plant vigor more than phosphorus or potassium. Chilling requirements for rabbiteye blueberry was determined and a close association was found between artificial constant chilling and natural chilling on floral and vegetative buds. (Poplarville, MS)

Captafol, chlorothalonil, benomyl, and captan fungicides in various schedules and rates were evaluated for anthracnose fruit rot control on highbush blueberry. The outstanding treatment was three applications of captafol at 4 lbs/acre on a 15-day schedule followed by two sprays of captan. For the third season, it has been shown that captafol treatments applied during the growing season for control of anthracnose fruit rot are significantly reducing the amount of viable inoculum overwintering on dead stems. It has been shown that dead blueberry stems cut from prunings left lying on the ground for up to 6 weeks still have viable anthracnose fungus present after being buried in the soil for up to 8 weeks. (New Brunswick, NJ)

Cranberry Studies

In a comparison of several fungicides for cranberry fruit rot control, Dithane M-45 was the most effective treatment being significantly better than chlorothalonil and captafol at the same rate and spray schedule. Fungicides were evaluated for their effect on cranberry fruit yields on the Early Black cultivar. The plots were established on cranberry bogs where fruit rot had been well controlled in previous seasons so that rot would not distort the yields in the

unsprayed checks. In the first 2 years of this study, wide variations among replications produced no statistically significant results although certain relationships among treatments held in both seasons. In an experiment to correlate pollinating bee activity with timing of fungicide applications for cranberry fruit rot control, the results were inconclusive. A comparison of hand versus vacuum picking of square foot plots used in the yield experiment has shown that almost twice as many berries can be picked with vacuum equipment compared to hand picking. (New Brunswick, NJ)

Small Fruit Virus Research

Stocks of commercial varieties of caneberries and strawberries found by indexing to be free from viruses were maintained in screenhouses and distributed to foreign and domestic agricultural officials. Heat treatment, meristem tip, and culture were undertaken. An isolate of Phytophthora erythroseptica from red raspberry in Washington, when inoculated into root systems of 4 red raspberry cultivars in field plots, caused a 57% decrease in yield. Canby and Willamette varieties were very susceptible; Newburgh and Summer cultivars were not much affected. Raspberry mosaic virus at a low incidence level was the only virus found moving into commercial Oregon fields of certified Willamette red raspberry at a low rate over a 3-year test period. In cooperative tests with the Oregon Department of Agriculture, wild Himalaya blackberry was found not to be a virus reservoir for commercial Rubus in Oregon. In a study of the effects of viruses on Hood strawberry, growth was significantly reduced by 20% by chronic virus infection by aphid-borne viruses. (Corvallis, OR)

Grape Viruses

Cabernet Franc, a grape cultivar used as an indicator plant for grapevine leafroll in Australia, appeared to be more sensitive to mild leafroll strains than Mission, the cultivar currently used for indexing. A better indicator will assure greater confidence in the certification for freedom from mild virus strain. In an experiment to measure the effect of leafroll virus on grape production, disease-free Pinot Noir lines produced 1.5 lbs more fruit per vine. Efforts to repeat mechanical transmission of leafroll virus from grapes to Nicotiana species by DNA extraction techniques which were reported by Israeli pathologists failed. The causal agent of leafroll appears to be a virus but we have not been able to demonstrate the fact that it is. The disease yellow speckle

can be detected when affected plants are held at 90° in a growth chamber for 4 weeks for conditioning and then moved to a constant temperature of 70° for 4 additional weeks. Yellow speckle has been difficult to diagnose or index and many certified grape clones in the California clean stock program are known to carry this virus based on indexing tests carried out in Australia. (Davis, CA)

Fanleaf virus causes damage to grape production. The vector of fanleaf, Xiphinema index, in addition to being a vector causes damage to vines by feeding on and destroying roots. Cooperative work with nematologists showed that Pratylenchus vulnus, a nematode that is often present on grape roots in complex infestations with X. index, causes greater damage to roots than X. index does. P. vulnus is a more aggressive pathogen than X. index and when both nematodes are present in a mixed population, the numbers of X. index gradually decline. (Davis, CA)

Pierce's disease (PD) is apparently caused by a fastidious rickettsialike bacterium as was originally reported and not Lactobacillus sp. as reported by others. The Lactobacillus sp. that was isolated from PD vector insects cannot be isolated from affected plants, cannot be injected to healthy vectors making them infective, and does not possess a cell wall structure that is the same as the bacterium found in xylem elements of PD affected grapevines. The bacterium was found in xylem tissues of grapevines sent from Stoneville and Verona, Mississippi, which establishes that the disease causing decline of grapevines found in that State is Pierce's disease. (Davis, CA)

Citrus Rootstocks

Test plots of grapefruit trees on Swingle citrumelo, a high-yielding rootstock, and other rootstocks located in six locations in the Rio Grande Valley are doing well in all locations. Nurserymen and growers are still requesting seed of the Swingle citrumelo. The Fairchild and Fortune mandarins had higher yields than the Bower on all six rootstocks in 1975. (Weslaco, TX)

Nearly 8000 citrus seedlings, representing more than 200 individual lots, were tested for tolerance to Phytophthora root rot. These included large numbers of salt-resistant hybrids developed earlier. Desirable survivors of these and earlier tests have been field planted. The 10 field trials of citrus rootstocks in the Coachella Valley and Ventura County have made good progress and are yielding valuable data on Phytophthora tolerance, growth, and yield. Growers show substantial interest in these trials. (Indio, CA)

Citrus Diseases

Phytophthora citrophthora, which is being evaluated for milkweed vine control, does not cause root rot of sweet orange seedlings, whereas P. parasitica causes severe root rot. (Orlando, FL)

Found a virus in Star Ruby grapefruit trees that may be citrus necrotic ringspot virus. Initiated tests to determine identity of this virus. Studied host, isolate, and tissue age effects on tristeza particle concentrations. Determined combinations that allowed purification of tristeza particles in mg quantities for production of tristeza antisera. Continued research on tristeza strain characterization and cross protection. (Orlando, FL)

Demonstrated that coat protein from noncitrus viruses such as alfalfa mosaic, tobacco streak, and Tulare apple mosaic could activate noninfectious RNA mixtures from citrus leaf rugose virus. Showed that particle size was correlated with sedimentation velocity of citrus variegation and citrus leaf rugose viruses. Tested the reaction of Etrog citron indicator plants, the standard indicator for exocortis, for reaction to eight other viruses and found visible reactions to four. Demonstrated that high temperature growth conditions allowed the development of exocortis symptoms and suppressed the stunting and stem pitting effects of tristeza which often interferes with the exocortis indexing test. (Orlando, FL)

Citrus Blight

Fusarium was found in fibrous roots of citrus trees with blight but culturing wood pieces from the interior of roots failed to reveal any fungus or bacteria peculiar to blight trees. Citrus trees on shallow soils develop blight more rapidly than deep soils. Water movement in xylem vessels of blight trees was found to be restricted and early-stage declining trees were shown to have some roots and portions of the trunk with restricted water movement in the xylem vessels. Demonstrated that blight trees had more feeder roots, greater starch reserves, and less water conductivity than trees affected by tristeza. Some organic compounds have been extracted from citrus tissues to determine their involvement as causative agents of blight. Ethylene and methane levels in the soil have been monitored during the season. No conclusions as to their effect on citrus trees can be drawn. Ammonia levels in the soil have no relation to citrus blight. A seaweed extract purported to cure blight symptoms has shown no cytokinin activity in standard cytokinin bioassays. (Orlando, FL)

Cold Hardiness of Citrus

Starch does not appear to play a major role in citrus cold hardening. Starch hydrolysis is minimal while sugars increase during hardening. Valencia orange trees accumulate carbohydrates most rapidly between 15°C and 5°C, which are effective hardening temperatures. Tetrazolium reduction measures reducing potential of citrus tissues and differentiates cold hardened and unhardened tissues. (Orlando, FL)

Citrus Abscission Research

Satisfactory loosening of Hamlin oranges was achieved with Acti-Aid, Release, Pik-Off, and combinations of these. Pik-Off was not satisfactory when the weather was cold. Chlorothalonil prolonged the ethylene level and thus the cellulase activity in the separation zones. This resulted in a longer period for fruit harvest. Fruit yield and quality were not affected by previous year's sprays. Abscission chemicals were more effective in loosening Valencia oranges on Carrizo than on rough lemon rootstocks. However, during the regreening or retightening period in May, excessive chemicals had to be used, regardless of rootstock. (Orlando, FL)

Citrus Mycorrhizae Fungi

Sclerocystis sinuosa, Gigaspora margarita, Glomus mosseae, G. fasciculatus, G. macrocarpus mycorrhizae have been found associated with Florida citrus roots. Spore numbers decreased as soil depth increased, more spores were present in rhizosphere soil, and infection and spore numbers increased during the fall. (Orlando, FL)

Date Research

A mist system has been constructed in a glasshouse for studies on rooting of small date palm offshoots. Chemical stimulation of date offshoot production is being studied. Tissue culture of date palm was undertaken in an informal cooperation with Dr. T. Murashige, Department of Plant Sciences, University of California, Riverside. About 50 explant cultures are actively producing callus and other structures. (Indio, CA)

The metaxenia effect of pollen from 6 inbred male palms was studied. None induced as early ripening in Deglet Noor fruit as did pollen from the Fard 4 male. The variation in the effect of pollen on the time of ripening appeared to be as great within the inbred lines as between the different inbred lines. None appeared to shorten the duration of the ripening period of the fruit on the same bunch. (Indio, CA)

Growth Regulators for Pecans

Terminal bud dominance was inhibited and lateral bud break promoted in 6-year-old pecan trees by a slow release ethylene compound. This resulted in extensive lateral branching and a more compact tree desirable in high density plantings. The effect was more pronounced in trees that genetically tend toward branching than those that do not. Work is in progress to identify plant growth regulators in pecan fruit and to correlate the concentrations with physiologically active periods of fruit set, fruit development, flower induction, and flower differentiation. (Byron, GA)

Alternate Bearing in Pecans

We have established that in mature pecan trees, biennial bearing patterns are not necessarily alternate when tree size is considered. Often a tree will have two or three consecutive "on" years of "off" years. Irregular bearing within shoots of a given tree is shown to exist but to a lesser degree than among trees. The within tree variability of all variables measured was significantly greater than means among trees. Extremes in bearing among trees were associated with poor soil drainage and restricted root penetration. Moisture removed from a depth of 4 feet indicated root activity in terms of moisture and nutrient absorption at that depth throughout the growing season. (Byron, GA)

Pecan Nutrition Studies

The 5-year average of non-irrigated Stuart pecan trees that received 20, 40, and 60 pounds of nitrogen per tree, showed an increase above the unfertilized control of 21, 33, and 25 percent respectively. In the 2 "on" years, 1973 and 1975, the increase was 42, 61, and 55 percent respectively. Buddbreak was delayed from a few days to a week the past 3 years in direct relation to nitrogen applied. Length of shoot growth was not increased to the same magnitude as yield by respective treatments, suggesting the effect of nitrogen was largely other than providing more leaves per terminal. Total nitrogen in basal leaflets of basal leaves on the shoot was the most sensitive indicator of nitrogen uptake.

Pecan Nursery Stock

Studies on methods to increase uniformity of open-pollinated seedling rootstocks indicate that seed nut stratification for 12 to 16 weeks at 34° - 38°F, planting seed twice as close as normal in nursery rows, and roguing of small seedlings increases seedling uniformity over nursery methods previously used. (Brownwood, TX)

Walnut Diseases

Our studies on etiology of walnut blackline disease revealed that diseased trees occur in groups. The disease affects young trees which may die within 2-3 years, contrary to the belief that blackline is a slow decline of old walnut trees. Our preliminary results suggest strongly that this disease may be caused by an infectious agent rather than an incompatibility problem. Research has been initiated on the search of infectious agents. (Davis, CA)

Survey of walnut orchards with large number of declining trees revealed association of Phytophthora megasperma with diseased trees. Four different Phytophthora spp were isolated from dying raspberry plants affected with root and crown rot. These Phytophthora spp have never been previously reported to be associated with walnuts and raspberries.

P. cinnamoni, P. cactorum, and Phytophthora spp are implicated in crown and root rot and death of walnut trees. Preliminary results show marked difference in resistance of Regia, Paradox, and Hindsii walnut rootstocks to these pathogens. Regia was the most susceptible followed by Paradox and Hindsii to all three Phytophthora spp. P. cinnamoni was the most virulent followed by P. cactorum and Phytophthora spp to all three walnut rootstocks. This result indicated that precautions should be exercised in recommending use of Regia rootstock as a possible control measure for walnut blackline disease. (Davis, CA)

Almond Leaf Scorch

Research revealed for the first time that almond leaf scorch is a specific, infectious disease caused by a xylem invading fastidious bacterium that can be spread from diseased to healthy trees by leafhoppers, budding, and grafting. These findings are essential for the development of control measures for this disease that threatens to limit almond production in several important almond producing areas in California. (Davis, CA)

Filbert Research

Nearly 80 potential non-suckering filbert rootstocks have passed preliminary screening and are in various stages of evaluation and propagation. Four test plantings of 4 new varieties (plus Barcelona as a control) have been established throughout the Willamette Valley of Oregon. Each planting involves 150 trees grafted on a common rootstock. The 4 new cultivars are also being evaluated in Washington orchards that are infected with eastern filbert blight. (Corvallis, OR)

Trees in the 6' irrigated spacing averaged a record 9.7 lbs of nuts/tree or 3925 lbs/A. Less dense spacing trials yielded the following: 15' = 2648 lbs/A, 20' = 2130 lbs/A and 25' = 1485 lbs/A. The latter spacing has yet to exceed 1 T/A. After 5 years, the trees spaced at 25 ft occupy 56% of an acre; at 20 ft, 73%, and at 15 ft, 85%. Pruning tall, close-spaced trees by topping caused a 40% reduction in yield in the following year and a 10% reduction in the second year after pruning. Ethephon accelerated nut drop by at least 2 weeks in 1975 trials. Efficacy data for glyphosate in filbert orchards was developed. Application for the use of 2,4-D in filbert orchards was approved by EPA. A local registrant is being sought. (Corvallis, OR)

Weed Research on Hops

Testing of paraquat herbicide on hops was completed and data were provided to cooperators. Paraquat received EPA registration for use on hops for weed control and suckering.

Reduced tillage tests on hops with various herbicide treatments for weed control were continued. A combination of simazine (fall) and paraquat (spring) was very effective for weed control. However, non-tilled plots produced lower yields regardless of weed control treatments used. (Corvallis, OR)

Virus Studies in Hops

Virus symptoms developed on an additional 20-30% of seedling hop lines from a progeny from parents free of Prunus necrotic ringspot (PNRV). The virus was tentatively identified by Dr. C. B. Skotland, Washington State University plant pathologist as not being Prunus necrotic ringspot but a rod type capable of being transmitted by aphids. Several thousand hop seedlings from reciprocal crosses between PNRV-free and infected plants were field grown for virus evaluation. Additional reciprocal crosses were made in temperature-controlled chambers for virus transmission studies by Washington State University. (Prosser, WA)

Alpha-Acid Production in Hops

Soft resin maturity curves were obtained on the Comet hop grown under low, optimum, and high soil nitrogen levels. The formation of resins was enhanced by low nitrogen and delayed by high nitrogen levels. Reduction of alpha-acid content of hops grown under high nitrogen was due to immaturity rather than lack of synthesis. Increase of alpha-acid content in virus-free commercial varieties was related to an increase in lupulin gland development. Meristem-cultured Northern Brewer hop, which is free of Prunus necrotic ringspot and also some rod-type viruses, had 20% higher alpha-acid production than clones

free of only the Prunus necrotic ringspot virus. (Prosser, WA)

Mint Disease Research

Long term work on Verticillium wilt control in mint, using reduced tillage in combination with crop rotation and herbicides, was completed. The best management combination was no tillage on mint combined with flaming mint stubble after harvest to kill wilt spores and the use of terbacil herbicide. When this was combined with a 4-year crop rotation to corn, wheat, corn, wheat before mint, average yield of mint oil was increased from 65 to 84 pounds per acre over an 8-year period. When combined with a 4-year alfalfa, 4-year mint rotation, the yield was increased from 65 to 76 lbs/A over an 8-year period.

Publications

There were 104 publications on fruits, nuts, and specialty crops during 1976.

NRP Annual Report
FY 1976

NRP 20020 Breeding and Production--Vegetables

NPS Contact: A. E. Kehr

PACS Contact: L. L. Jansen

This ARS National Research Program involves research in breeding and production of vegetables to develop new and improved genetic and cultural methods that will result in lowering costs of vegetables and potatoes to consumers and increasing efficiency of production of these crops to growers, small acreage farmers, and homeowners. Geneticists, plant pathologists, plant physiologists, and horticulturists (both Federal and State) work in a team approach to evaluate and improve vegetables and vegetable cultural methods.

The research is conducted at 17 locations in 14 States in both Federal and State Stations, where ARS scientists usually work as a team with State scientists.

In 1975 vegetables and potatoes (including dry beans and peas) were harvested from 6.5 M acres with an aggregate value of \$4.7 billion.

TECHNOLOGICAL OBJECTIVES

This Research Program has two primary technological objectives, as follows:

- 1 New and improved genetic populations, breeding lines, and varieties of vegetables that combine improved yield potentials and favored quality characters, including reduced contents of undesirable constituents, with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting, and handling.
- 2 New and improved cultural and management practices that increase vegetable yields, minimize production losses, improve quality attributes, and conserve and use scarce resources efficiently.

GERMPLASM DEVELOPMENT

Potatoes

Parental Development. Parental combinations are being developed combining wide adaptability, ability to process directly from 40 degrees F. storage, resistance to leafroll, tuber net-necrosis, golden nematode, scab, late blight, immunity to virus Y and resistance to the leafhopper in both white and russet skin clones. Approximately 250 selections were evaluated for resistance to viruses A, X, and Y. Eleven promising clones were entered in the uniform trials being conducted in Florida, Virginia, New Jersey, and Maine. B6987-56, a widely adapted high quality, pest-resistant clone is being named as variety Atlantic. B7147-8 and B7583-6, two russet promising clones, are in grower trials.

New Russets Near Release. Long-russet selection A6371-2 is superior in quality of dehydrated products to the standard Russet Burbank cultivar in 4 years of processing evaluations and superior in yield of U.S. No. 1 tubers in 8 years of field trials. It is also acceptable for processing into french fries and for the fresh market as a baker.

Long-russet clone, A68678-1, outstandingly superior in processing quality (high solids, very low sugars, excellent texture), produced top yields in Idaho, Washington, Oregon, and California.

Tomatoes

Resistance to Fruit and Soil Rots. Emphasis was continued on combining useful levels of anthracnose and Rhizoctonia soil rot resistance with good horticultural characters. In addition to the three P.I. lines presently being used as sources of Rhizoctonia soil rot resistance in the breeding program, several other potential sources were found. However, these need to be confirmed next year.

Mushrooms

Germplasm Collection. Thirty new isolates of cultivated mushrooms were added to the Mushroom Project's permanent collection of germplasm. Mushrooms (Shiitake) continued to be harvested from the established Beltsville forest plots.

Pumpkins

Insect Resistance. Sixty-seven pumpkin cultivars/lines were screened in cage houses for resistance to the red pumpkin beetle. One accession showed no feeding damage while all others showed varying degrees of susceptibility.

Lima Beans

Anthracnose Resistance. Cooperative field tests in Georgia and Tennessee verified greenhouse inoculation tests and showed that two lima bean introductions are resistant to anthracnose. Individual anthracnose resistant plants were selected in the F_3 , the BC_1S_1 , and the BC_2S_1 generations of crosses involving the two P.I. lines and Jackson Wonder.

Nematode Resistance. Advanced breeding line L40215 has nematode resistance and green cotyledons, but in field trials it was more heterogeneous than desired for both of these characters. Single plant selections were made from a planting of L40215 at Tifton, Georgia, in a root-knot nematode infested field which should eliminate most of the heterozygosity.

Green Beans

Rust Resistance. Seven cultivars and lines were resistant at all locations in all years tested and 15 were field resistant (slow rusting). A hybridization program was continued to breed snap beans with both single and multiple gene resistance to bean rust races. A breeding program was initiated to produce pinto beans resistant to rust for the North Dakota-Minnesota production area. The International Bean Rust Nursery was grown in the United States for the first time.

Carrots

Release of Inbreds. Three inbreds were released in June 1976. They will make up a new fresh market hybrid that will be named and released before October 1, 1977. Extensive commercial and experimental trials in California and Arizona show this hybrid to be equal in yield and better in uniformity, pack-out percentage, and market quality compared with currently used varieties.

Onions

Long-Storage Inbreds Developed. New inbred lines with the long-dormant characteristic, tested in yield and storage trials, proved superior to those previously tested and to the recently released Spartan Sleeper. After 11 months of non-refrigerated storage and with no sprout inhibitor, the best hybrids had less than 15 percent loss from sprouting while all currently used cultivars were over 90 percent sprouted.

Cucumbers

Female Types for Use in Hybrid Seed Production. In an effort to introduce femaleness and hermaphroditism into six American cucumber varieties, backcross three generations were self-pollinated and selected. The gynoecious cucumber line GY-3 was selected for the fourth time for increased femaleness.

Progress in Development of Disease and Insect Resistance. New methods for evaluating cucumbers in cotyledon and early true-leaf stages, developed in cooperation with the University of Wisconsin, have permitted rapid and efficient combinations of multiple disease resistance with beetle resistance and horticultural quality. One line W744GP is being increased under contract in California in preparation for commercial trial and probable release. This is a gynoecious, parthenocarpic non-bitter inbred with resistance to cucumber beetle, scab, mosaic (CMV), powdery mildew, anthracnose, and downy mildew. A companion pollen parent with the same characteristics, but with hermaphrodite sex-expression (W1092HP), was increased under screen and is being used to produce experimental hybrid seed (W744GP x W1082GS) for trials in 1977 to determine feasibility of producing seedless cucumbers.

Seedling tests for resistance to *Corynespora* leaf blight and bacterial wilt were used routinely for developing multiple disease resistance. The first successful seedling tests for resistance to angular leaf spot were accomplished. Large populations of seedling plants are now being evaluated for beetle resistance and for eight of the nine cucumber diseases causing serious losses in the U.S.

Rhubarb

Virus-Free Clones Developed. After several years of effort, virus-free clones of forcing type rhubarb have been obtained.

Tropical Vegetables

Breeding Program Initiated. F_1 progenies of selfed *Xanthosoma* and *Colocasia* cultivars were studied under field conditions. Both groups showed substantial differences in vigor, corm size, and other characteristics. The data indicate that productive breeding programs are entirely feasible with both genera.

Edible Grain Legumes

Germplasm Development. A wide range of germplasm including *Phaseolus vulgaris*, *P. acutifolius*, *P. coccineus*, *P. lunatus*, and *Vigna unguiculata* was simultaneously screened and compared for response to diseases. A large number of F_2 population with multiple disease resistance were developed.

A total of 4,196 pigeonpea accessions collected in India by the Regional Pulse Improvement Program were evaluated. The collection was a broad range of germplasm.

A large mung bean (*Vigna radiata* L.) collection has been evaluated in India for yield, quality, and disease resistance. Sufficient variability has been found to justify a breeding program aimed at improving yields and protein content in early maturing disease resistant types.

Melons

Pest Resistant Lines Developed. About 1,000 varieties, plant introductions, new crosses, and breeding lines were evaluated for disease resistance. Fifty-seven lines were found that retained good foliage under severe incidence of downy mildew, powdery mildew, alternaria, and gummy stem blight. F₄ populations of breeding lines C921, C927, and C928 performed very well in a poor melon growing season, producing many top quality fruit without any fungicide application.

One selection of breeding line 63-4-M1-18-M8 remained free of aphids in a heavily infested field. It produced a high yield of fruit with good levels of ascorbic acid and soluble solids.

Lentils

Lentil Yields Markedly Increased. Seed yields of spring lentils are reduced by heat stress. Lentil plants were identified that resisted temperatures of 23 degrees C. without apparent damage. Winter-type lentils were selected that increased seed yields by more than 100 percent for 2 consecutive years. Winter lentils sown in no-tillage seedbeds increased seed yields twofold and were harvested before other field crops were mature.

Dry Beans

Highly Disease Resistant Types Being Developed. Through continued intercrossing of Fusarium-resistant selections, effectively high levels of root rot resistance have been established in early-maturing short-vine types desired by growers. Foundation seed of an early pea bean and two early Red Mexican selections will be increased for prospective release to the industry in 1977. Yield testing in early and late plantings has made possible selection for ability to resist environmental stresses such as low soil temperatures during germination and seedling growth, and high temperatures and drouth during blossom, pod, and seed development.

In dry bean improvement, progress was made in the development of root rot, virus, and environmental stress-resistant, high-yielding, earlier-maturing Small White, Pinto, Red Mexican, Red Kidney, and Pink beans. Excellent selections were made in all the above bean types which have curly top resistance and horizontal resistance or immunity to all known Bean Common Mosaic Virus strains, a kind of resistance found presently in very few bean cultivars.

Rust Resistant Pintos Being Developed. (See information above under Green Beans.)

Resistance to Air Pollution. Tolerance to air pollution damage, caused primarily by ozone, has been transferred into dry beans of the Navy (pea) type; sources of tolerance included breeding lines 0685 and 0686, and California Small White #59. Resistance to damage appears to be inherited in a dominant manner. Studies involving open-top chambers indicate that ambient O_3 levels during the growing season were sufficient to reduce, by 50³ percent, overall plant growth of the susceptible Sanilac Navy bean cultivar.

Sweet Corn

Corn Earworm Resistance. A broad-based sweet corn composite was advanced through the third cycle of tandem mass selection. The selection procedure was applied to a 3,000 plant population that resulted in simultaneous improvement of several agronomic characters and earworm resistance. Thirty-three of the most resistant ears, that also had superior conformation and quality, were saved from the S_3 generation, to reconstitute the fourth cycle of tandem mass selection.

High Sugar Types. Work was continued toward the development of high-sugar genotypes using the endosperm mutant genes amylose extender (ae), dull (du), and waxy (wx). Test crosses were made on the F_3 's, BC_4F_3 's with an ae wx tester line to verify genotypes. Only 8³ of these 4³ lines tested positive for triple mutant (ae du wx) genotype. The du wx genotype was most frequently mistaken for ae du wx by visual inspection. For this reason, test crosses with known genotypes are essential for positive identification of endosperm genotype.

Sweetpotatoes

Fusarium Wilt Resistance. All advanced regional entries were found to possess a level of resistance to fusarium wilt (FW) equal to or better than Centennial, the intermediate, FW-resistant cultivar. One Virginia line (VP 9-51) was shown to have a high level of resistance equal to Jewel, the high resistant standard cultivar. This line will be released to growers under the name Painter.

Root Knot Nematode Resistance. Rapid progress continued to be made in increasing the frequency and level of resistance to the southern root-knot nematode (SRKN) in sweetpotato breeding materials. One plant introduction (PI 399163) was found that appears to have immunity to our isolates of SRKN. An advanced line (W-51) was found to have high resistance to the 'new race' of SRKN.

Lettuce

New Head Lettuce Selection Nears Release. A tipburn and downy mildew resistant breeding line of lettuce with exceptional quality including excellent flavor and head structure and uniform maturity for mechanical harvest was selected to increase for release. It will be useful to breeders as a source of tipburn and downy mildew resistance and of superlative plant structure. The marketable heads are small but it may prove useful to growers in locations and seasons where size is not a problem. It should be useful, also, to home gardeners.

Romaine Lettuce Selection Promising. A downy mildew resistant cos (romaine) breeding line with excellent plant structure and flavor and good size and firmness was also selected to increase for grower trials.

VARIETY DEVELOPMENT

Potatoes

Atlantic. Atlantic is an unusually promising new medium-late, white-skinned potato combining high quality with high yields, wide adaptation, multipest resistance, and multiple use. Chief among its pest resistances is resistance to golden nematode. It is also immune to virus X, and resistant to tuber necrosis, late blight, common scab, and hopperburn. The tubers are smooth, blocky round in shape, with a heavy netted skin and shallow eyes. Atlantic was consistently higher in specific gravity at all test locations than locally grown varieties. It is adapted for fresh market, and some processed products, especially chips.

Centennial Russet. Centennial Russet is a new oblong, blocky, slightly flattened potato with netted skin and shallow eyes. Over a 4-year period in 18 trials in Colorado and California, it has outyielded Russet Burbank in both total yields and total US #1 grades. It has shown resistance to early and late blights and verticillium wilt.

Alaska Red. Alaska Red is a general purpose productive red-skinned potato. Alaskan consumers have depended upon imported "reds" from other regions up to now. Alaska Red has proved in variety trials to be the best adapted and most productive red-skinned, white-fleshed potato. The tubers are oval to flattened round, uniform in appearance, and have very shallow eye basins. Except for scab of the tubers, diseases have not been observed on the foliage or on tubers in storage.

Lettuce

Two head lettuce varieties were released. Salinas is crisphead lettuce, which is highly resistant to tipburn, mature uniformly giving a high density harvest, and has excellent flavor and texture. Vanguard 75 is the first head lettuce developed with mosaic resistance. In most other respects, it has the same attributes as its highly successful predecessor, Vanguard.

Dry Peas

Garfield and Tracer. Two green pea selections, 'Garfield' and 'Tracer,' have been released and offered for production in the Palouse. The major improvements of Garfield over 'Alaska' strains are 15 percent greater yield, more uniform seed size, greater plant height, and resistance to pea root rot. The major improvements of Tracer over small-sieve, Alaska strains are 45 percent greater yield; more uniform seed size, shape, and color; greater plant height; and lower susceptibility to seed bleaching. Tracer is resistant to Fusarium wilt race 1.

Reasons for improved yield potential of Garfield and Tracer include resistance to pea root rot and the resulting ability to extract more moisture from the soil profile. Garfield and Tracer extracted moisture to 120 cm, whereas Alaska types could only extract moisture to the 90-cm depth. Water use was highly correlated with seed yields.

Tomatoes

Roza, Columbia, Rowpac, and Saladmaster. Four cultivars of curly top resistant tomatoes were released in FY 1976. As in the previous 4 years, the new cultivars, Roza, Columbia, Rowpac, and Saladmaster demonstrated resistance to curly top, Verticillium, and Fusarium wilts, outstanding yields, and good fruit quality. Also in FY 1976 these four cultivars were found to process well. Roza has unusually high levels of vitamin C and viscosity, and Saladmaster has very low pH and high total acids and sugar. Rowpac was promising as a machine harvest variety in California, and Roza was selected as best in an extensive Florida trial. Six other advanced early-ripening curly top-resistant lines proved well-adapted to machine harvest, with good yields and processing quality. Trials at several locations indicated these lines are worthy of extensive evaluation by growers and canners interested in a machine-harvestable tomato for processing in areas where curly top is a hazard.

Dry Beans

Five Bean Varieties Were Released. Ecuador 299 is a red-seeded dry bean which has been consistently resistant to bean rust. It is also resistant or tolerant to rhizoctonia root rot, rhizoctonia stem canker, charcoal rot, ashy stem blight, Fusarium root rot, and southern blight.

Palmarejo. Palmarejo maintains an excellent stand in the field and its leaves remain relatively disease-free even during the summer rainy season in Puerto Rico. This cultivar has been highly resistant to rust (Uromyces phaseoli) races endemic to Puerto Rico. It is also resistant to common bean mosaic virus. In some plantings it has shown a slight diffuse chlorosis which was not mechanically transmissible. The leaves of this cultivar have been free from bacterial (Xanthomonas sp.) lesions until pods begin to mature.

Congo Rico. Under severe rainy season conditions, this cultivar suffers moderate incidence of rhizoctonia root rot (R. solani) and charcoal rot (Macrophomina phaseoli), but it retains a good stand in spite of the adverse conditions. It has a strong and well formed root system which when infected responds by producing profuse adventitious roots from the stem near the ground. Congo Rico is a high yielding cultivar, producing 2.30 tons per hectare when planted in dry weather at Lajas. It matures at 71 days when planted in February and 73 days when sown in July.

Oro Rico. This cultivar is high yielding, producing 2.86 tons per hectare. The dry seed weight of 100 beans is 21.0 grams during the dry season and 12.5 grams during the wet summer season. Oro Rico is resistant to common bean mosaic virus and rhizoctonia root rot (R. solani), moderately resistant to powdery mildew (Erysiphe polygoni). It is moderately resistant to leaf miner (Liriomyza sp.) and susceptible to root knot nematode (Meloidogyne incognita).

Violeta. Violeta retains a good stand in the field, is moderately tolerant to bacterial blight and moderately resistant to rust. It is resistant to common bean mosaic virus and cucumber mosaic virus. It has been field tolerant to whitefly transmitted viruses. This cultivar is characterized as high yielding, multiple disease tolerant and adaptable to warm humid tropical conditions.

Breeding Lines

Snap Bean Breeding Line B4000-3. B4000-3 exhibits a strong, upright growth habit that elevates pods well above the soil surface. Plants are well anchored by a vigorous root system and lodging has been minimal. Pod set is concentrated for once-over harvest and productivity has been high, especially in the Southeastern United States.

Lima Bean Breeding Lines B2C. Baby lima bean breeding line B2C was released because it carries resistance to all known races of downy mildew caused by Phytophthora phaseoli.

GENETICS AND BREEDING

Potatoes

Glycoalkaloids. In several small families of Solanum chacoense hybrids, apparently 3:1 and 1:1 ratios occurred for certain tuber glycoalkaloids detectable by TLC, indicating segregations of single genes involved in their synthesis. The overall inheritance pattern of the glycoalkaloids may not be as simple, however, in view of the quantitative variations, nonrandom associations and recombinations that were encountered.

Insect Resistance. Breeding clones were field tested for resistance to potato leafhoppers and potato flea beetles. Consistent with previous tests, B6712-9, B6761-11, B6558-2, and BR7103-7 exhibited low leafhopper infestation and hopperburn levels, and B6930-1, B7165-6, and B6987-56 supported moderate infestations but developed hopperburn slowly. Of the clones with limited previous testing, B7132-27, B7138-8, B7196-40, B7608-4, B7621-10, and B7678-17 resisted infestation the most. All but 6 of the 38 clones had significantly lower leafhopper infestation levels than susceptible check Cobbler. Yield-loss due to insect infestation ranged from 51 to 80 percent among 14 clones tested. B6930-1 was the most tolerant, as in previous tests. Flea beetle infestations were too low for reliably detecting differences among the test clones; however, B6558-2 was, as in previous tests, among those with the lowest infestation levels.

Identification of the Extra Chromosomes of Trisomics in Solanum chacoense. Four secondary trisomics, identified by pachytene analysis in S. chacoense, were analyzed with Giemsa stain and it was demonstrated that chromosomes IV and IX in pachytene analysis correspond to chromosomes C and F, respectively, in Giemsa stained somatic cells. The centromere of the two chromosomes was located using two pairs of secondary trisomics.

Tomatoes

Resistance to Early Blight. A study on the inheritance of early blight resistance (leaf spot phase) showed that several genes were involved and that resistance was inherited in a recessive manner. The necessary populations were obtained for a study next winter on the inheritance of resistance to the Colorado potato beetle.

Cucumbers

Virus Resistance. Two cucumber lines from Surinam were found highly tolerant to watermelon mosaic virus 2 (WMV). Both lines were mild reactors to WMV 1.

PATHOLOGY

Potatoes

New Method of Maintaining Disease Cultures. Isolates of Alternaria solani, Fusarium oxysporium f. sp. avenaceum, F. roseum f. sp. sambucinum, F. solani f. sp. eumarti, F. solani f. sp. coeruleum, and Helminthosporium solani were maintained for 18 months on a desiccated rye grain culture medium. This method alleviates the necessity for frequent culture transfers, reduces chance of contamination, supports sporulation and permits the immediate use of sub-transfers of these cultures as inoculum.

New Virus Identified in Washington. An outbreak of tobacco rattle virus, which causes corky ringspot of potato, was positively diagnosed for the first time in Washington. Development of resources for whole virus and D-protein serological diagnosis were completed for viruses X, S, and Y, and other resources for biological diagnosis were accumulated.

Lima Beans

New Race of Downy Mildew Found. A new race of downy mildew, designated race "D" was identified in field plots at Beltsville, Maryland. Germplasm resistant to race D was identified.

Green Beans

New Host for Bean Virus. Bean common mosaic virus (BCMV) was isolated from Rhynchosia minima, a tropical leguminous weed, growing at Palmira, Colombia. It was transmitted by aphids and bean seed. This is the first report of BCMV occurring naturally in a wild host. Infected R. minima may be a factor in the epidemiology of the disease in the tropics.

Virus Differentials Developed. A set of differential bean host tester varieties has been developed for identifying strains of bean common mosaic virus. These bean varieties will be increased and deposited in the National Seed Storage Laboratory for future workers. The BCMV strains used in this study will be deposited in the American Type Culture Collection.

Control of Blue Lake Bean Necrosis Found. The bean disease, Blue Lake bean necrosis, was found to be caused by a necrosis-inducing strain of bean yellow mosaic virus (BYMV-N). The almost-exclusive natural reservoir of this virus was found to be perennial stands white clover (Trifolium repens). The means of natural spread of BYMV-N from white clover to beans was determined to be aphid spp., probably the clover aphid (Nearctaphis bakeri). The maximum distance of natural spread from white clover was about 100 meters; i.e., spread beyond this distance did not cause economic loss.

Recommendations that bean plantings be separated from white clover stands by about 100 meters, preferably upwind, and that white clover be eradicated in field-border areas were distributed to bean growers in 1974 and 1975. Results suggest that Blue Lake bean necrosis can be virtually eliminated as an economic disease by these rather simple cultural and management practices.

Virus Diagnostic Key Being Developed. The first-phase, tentative diagnostic key using 23 differential host species was developed for identifying the northern hemisphere, mechanically transmissible legume viruses. Host differentials were found for elucidating definitive bean yellow mosaic virus strain relationships.

Muskmelons

Alternate Hosts for Downy Mildew. Two wild cucurbit species, Cucumis sp. and Sechium edule, growing wild in Texas, were found to be alternate hosts in the epidemiology of downy mildew.

Vegetable Transplants

Soil Fumigants Studied. Six general soil fumigants applied by different methods reduced southern blight (Sclerotium roflsii) in field-grown tomato transplants, but they varied greatly in effectiveness. Vapam was the most effective and gave better control when applied as a drench than when injected or incorporated into the soil. Chloropicrin (Picfum, injected), methyl bromide (MC-2), and Terr-O-Gel (injected under polyethylene) were moderately effective in reducing disease incidence. Vorlex (water soluble formulation) significantly reduced disease incidence, but gave poorer control regardless of the method of application. Terr-O-Gel and Terr-O-Cide injected into the soil were also less effective than most other treatments. Vapam not only controlled southern blight, but also drastically reduced severity of early blight--a foliage disease.

Soil fumigants, Vapam drenched at 80 gal/A, MC-2 at 435 lb/A under film mulch, and Chloropicrin chiseled at 200 lb/A with water seal produced highest marketable onion transplant yields for late summer seeding.

Southernpeas

Leaf Spot Losses. Cercospora leaf spot on southernpea was found to be a much greater problem on domestic production than has heretofore been realized. The disease reduced the yield of a susceptible cultivar by 35.6 percent.

Tropical Vegetables

Dasheen Mosaic Viruses Purified. Two dasheen mosaic (DMV) isolates were purified and used to prepare antisera for serological investigations. Tests with the antisera confirmed the presence of DMV in Florida plantings of dieffenbachia, aglaonema, dasheen, and malanga. DMV also was identified in an Egyptian planting of Colocasia antiquorum.

Dry Beans

Weedicide Suppresses Fusarium Wilt in Greenhouse Tests. The herbicide Treflan incorporated at 1 or 2 lbs/acre inhibited the development of Fusarium wilt (race 1) in the greenhouse and growth chamber. The suppression of wilt symptoms is thought to be due to the inhibition of lateral root growth by Treflan which thereby limits the number of infection sites where the race 1 Fusarium can penetrate the host.

Possible Biological Control of Fusarium Wilt by Soil Fungi. A Warden silt loam soil, previously reported to be suppressive to Fusarium root rot of beans was found also to be suppressive to the bean and pea root rot Fusarium and common wilt Fusarium of peas (F. oxysporum f. pisi race 1). The suppressive effect of this soil was lost if Dexon (p(Dimethylamino) benzenediazo sodium sulfonate) was incorporated in this soil at a rate of 200 ppm. These results suggest soil organisms, probably fungi, are involved in suppression of Fusarium in this Warden silt loam soil.

PHYSIOLOGY AND CULTURE

Potatoes

Vitamin C. There were highly significant differences between families in tuber ascorbic acid (Vitamin C) content, indicating good potential for increasing contents of this vitamin through breeding and selection. Among 10 wild tuber-bearing Solanum species, S. stoloniferum had the highest Vitamin C content (25.4 mg/100g). This species may be a desirable germplasm source for increasing Vitamin C content in potatoes. Tubers of 5 PI lines of S. stoloniferum that were sampled had Vitamin C content ranging from 14 to 44 mg/100g.

A New Glycoalkaloid Found. A new, major glycoalkaloid (contents as high as 40mg percent fresh weight in tubers and 400 mg percent) was isolated from certain PI lines of S. chacoense and chemically characterized. This glycoalkaloid, named commersonine, has demissidine as its aglycone and one mole of galactose and three moles of glucose in its sugar moiety. Commersonine was more repellent to the Colorado potato beetle than tomatine, solanine, or chaconine and may be involved in resistance to this pest.

Close Spacing Increases Yield. Yield increases of Alaska Frostless potatoes over conventional 3-foot rows spacing were as great as 40 percent when the crop is planted in rows 18 inches apart. No tillage is required with this variety as its tubers develop deep in the soil.

Cabbage

Tissue Culture. Vegetative propagation in vitro of cabbage from stump buds and tissue from other plant parts as a method to increase breeding lines was continued. By passage of explants, multiplication averaged 65 shoots per stump. Mature heads of normal size and flowering plants were obtained from cultured cabbage tissue.

Tomatoes

Extracts Associated with Cold Tolerance Isolated. Preliminary studies were completed on the selection for and nature of cold temperature germination in tomatoes. An extract was obtained from seed of a cold germinating line that will promote more rapid germination of seeds of normally poor cold germinating lines. Conversely, an extract was obtained from seed of a poor cold germinating line that will inhibit germination of a normally good cold germinating line.

Green Beans

Chlorogenic Acid Associated with Nematode Resistance. The production of chlorogenic acid by other genera has been implicated as an inherent factor associated with nematode resistance. Chlorogenic acid was successfully separated from bean plant extract by HPLC, but its quantitative detection at levels occurring in the plant was not achieved. New detection equipment has been obtained and it is expected to increase the sensitivity of the method for chlorogenic acid detection and quantification, which will be useful in the development of nematode resistant beans.

Dry Peas

Pea Rhizobium Strains May Be Inefficient. The overall amount of nitrogen fixed by peas in the Palouse is extremely low (2 kg/ha); inefficient Rhizobium strains may be the reason. Fusarium root rot had no effect on nitrogen fixation.

Dry Beans

Subsoiling Overcomes Some of the Losses by Fusarium Wilt. Placement of subsoiling chisels on the front tool bar of a tractor to rip the soil 12 inches deep near the paths of planters on the rear tool bar significantly increased bean yields in Fusarium-infested soil. Where chisels were used, roots penetrated the soil deeply and yields were as good with 10-day intervals between irrigations as they were with only 5-day intervals between irrigations with no chiseling. The 5-day irrigation frequency, like subsoiling, largely nullified the effects of root rot, again indicating that a constant access of bean plants to sufficient soil moisture is critical in reducing the effects of Fusarium root rot. Fusarium-resistant selections were much less influenced by root rot and by irrigation and tillage variables than were the susceptible selections.

NRP Annual Report
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NRP 20030 Breeding and Production--Florist and Nursery Crops

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This ARS National Research Program deals with multidisciplinary research to develop new technology for improving productivity and increasing efficiency in the production of florist and nursery crops to enhance urban and rural environments. This need for new knowledge makes it essential for ARS to provide research results on selecting, improving, protecting, maintaining, and cultivating plants for urban and rural home, landscape, and special purpose plantings such as parks, roadside, and shopping centers.

Florist and nursery crops fulfill a social rather than a biological need. They affect human feelings and attitudes and greatly enhance human surroundings. Green plants and flowering plants are being used increasingly in and around homes, offices, and public buildings. The retail value of foliage and pot plants is estimated at over \$1 billion annually. The growth in the bedding plant industry in the last few years is probably unexcelled by any other agricultural commodity.

The USDA-ARS research program in Florist and Nursery Crop Production Practices is located at three primary centers: Washington, D.C.-Beltsville, Maryland; Delaware, Ohio; and Corvallis, Oregon. Another center of excellence is being evolved in the Southeast. In addition, germplasm collections are being maintained in a marginal way at Savannah, Georgia; Miami, Florida; Mayaguez, Puerto Rico; Woodward, Oklahoma; and Mandan, North Dakota. These programs are located at Federal and State research stations where ARS scientists work closely with State scientists and closely complement research activities in State programs.

TECHNOLOGICAL OBJECTIVES

This Research Program has three primary technological objectives, as follows:

- 1 New and improved genetic populations, breeding lines, and varieties of florist and nursery crops that combine improved and favored quality characters, with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting, and handling.

- 2 New and improved cultural and management practices that increase florist and nursery crops yield, minimize production losses, improve quality attributes, and conserve and use scarce resources efficiently.
- 3 To enhance environmental quality, by reducing pollution and improving man's surroundings.

GERMPLASM DEVELOPMENT

Woody Shrubs and Trees

Breeding lines and germplasm have been developed in a large number of species. A few examples are:

Honeylocust resistant to mimosa webworm.

New magnolia hybrids with the hardy native magnolia,
M. acuminata.

Hybrids of Azalea and Rhododendron were made in the program to produce yellow-flowered evergreen azaleas.

White birches resistant to bronze birch borers.

Cotoneasters resistant to fireblight.

Development of a compact, dense flowering viburnum.

Camellias which are fragrant.

Florist Crops

Complex hybrids of impatiens were made for improved floral and foliage qualities among New Guinea (genome N=16 chromosomes), Java (J=8), Celebes (C=4), and Tangerine from Celebes (T=4). Analysis of different genomic combinations showed that the balanced combinations; i.e., NNJJ, NNTT, JJCC, etc., were fertile, and that the unbalanced forms were sterile. Some derived amphidiploids bred true to seed making them suitable for use by seed companies.

Virescent plants of New Guinea impatiens were isolated from chimeral forms. The virescent character in combination with foliar variegation improves the ornamental effect of the hybrids requiring light foliage colors.

Shade Trees

New elm selections are being evaluated to determine their resistance to Dutch elm disease and elm phloem necrosis.

A 2-acre, 32 source plantation of Colorado blue spruce was established at Delaware, Ohio. Small-scale progeny tests of red maple were established in Cleveland and Pittsburgh.

VARIETY DEVELOPMENT

Three everblooming cultivars of New Guinea hybrid impatiens were released. These are the first everblooming cultivars ever developed in this group. Two of these, 'Pele' and 'Aloha,' are propagated by cuttings. The third cultivar, 'Sweet Sue,' can be propagated by cuttings and by seed. It is an amphidiploid that breeds true from seed.

The 'Urban elm,' released on a limited basis in 1972 to the nursery industry is being propagated on a large scale to speed its availability to the public. This tree and a resistant American elm, Delaware #2, have been and will be distributed to cooperators to gain additional information about their adaptability and pest resistance.

DISTRIBUTION OF PLANT STOCKS

Cooperative evaluation and stock increase programs have promoted the expedient introduction of superior seedling selections produced by the research programs. For example, 8,000+ plants of two Pyracantha and two Lagerstroemia were distributed to 18 wholesale propagation nurseries for stock increase; and 110 plants of one Camellia were distributed to 11 cooperators for stock increase. In addition, 80 plants of one Ilex selection were distributed to 8 cooperators for evaluation.

PHYSIOLOGY

Leaf Flavonoids

A biochemical survey of leaf flavonoids in Gleditsia has been completed. Our major native species (G. trianthos) can be differentiated from all other species on a chemical basis, and true hybrids involving G. trianthos can be chemically verified. In addition, chemical analyses were used to identify an unknown specimen as the Chinese G. melanacantha, previously unknown in cultivation in this country.

Cellular Physiology

Two techniques for measuring the pH of individual cells were developed and used in studies of maturation and senescence. The relative absorption of a living cell at two selected wavelengths were shown to be correlated with pH and provide a non-destructive measurement of the pH of individual cells. Direct measurement of vacuolar pH was also accomplished. Using two micromanipulators, a commercial pH electrode and a reference electrode made in our Laboratory were inserted in the vacuoles of individual cells. The validity of the pH determinations has been established by a number of different criteria. The measurements confirm that adjacent cells in flower petals can differ by a full pH unit. The response to environmental stress as well as senescence are first manifested at the cellular level. One of the earliest responses is a change in vacuolar pH. Changes in pH are accompanied by color change, reduction of cytoplasmic streaming, and loss of membrane function and integrity. Our measurements and observations show that adjacent cells may age or respond to stress at very different rates.

Nature of Seedling Resistance to Dutch Elm Disease

Capric acid was identified as a fungitoxic material in American elm seed inhibiting to the growth of the Dutch elm disease fungus, Ceratocystis ulmi. The isolation and identification of the fungitoxic principle from 3-month old American elm leaves has been more complex than anticipated. Instead of a single fraction, five active fractions of differing physical properties are present. Crude material is being processed for chromatographic separations. Naturally occurring tolerance, up to 1000 ppm, of C. ulmi isolates to methyl 2-benzimidazolecarbanate hydrochloride (MBC-HCl) was demonstrated. The rate of development of tolerance in sensitive isolates and the mechanisms involved are being studied. Results indicate genes for tolerance occur in a population of a sensitive strain.

Chemical from azalea may prevent the onset of cataracts in diabetics

A new flavonol glycoside, isolated earlier from flowers of 'Red Wing' azalea was identified as 2"-O-acetylquercitrin (with the cooperation of Dr. R. M. Horowitz of the Fruit & Vegetable Chemistry Laboratory at Pasadena). This new flavonol glycoside is the most potent inhibitor of aldose reductase tested to date by the Eye Institute at the National Institutes of Health. This enzyme is involved in the formation of cataracts in diabetics. The new flavonol, and others with similar structure, may eventually delay or even prevent the onset of cataracts in diabetics as well as aid in assessing the role of aldose reductase in diabetic neuropathy.

Efficient light sources

The relative growth of Grand Rapids lettuce and Pink Cascade petunia in response to cool white fluorescent (CWF), low pressure sodium (LPS), and high pressure sodium (HPS), were compared at equal energy (400-850 nm watts per m²). LPS can be used as a sole light source to start and grow most plants in a controlled environment. It's effectiveness is based on the total amount of light in the 400 to 850 nm region and suggests the Action Spectrum II is the dominant photo-reaction controlling growth under these conditions. In an environment of LPS alone, plants are compact with intensely green leaves. As long as sufficient visible radiation was supplied, apparently without spectral preference, the growth of the plants was similar in height, number of nodes, and fresh weight. LPS was superior to the other two sources when light from incandescent lamps was applied simultaneously.

PATHOLOGY

Carnation etched ring virus

Carnation etched ring virus (CERV) was purified with yields of 50 to 400 ug/100g of tissue and an antiserum prepared to the virus. The yields of CERV from fresh Saponaria vaccaria leaf tissue was about the same or higher with a combined butanol, urea, and Triton X-100 treatment than with butanol alone but the quality of the preparation was sometimes better with the butanol treatment alone. Butanol, urea, and Triton X-100 clarification always gave more highly purified CERV preparations from frozen tissue than butanol clarification alone.

Camellia dieback

Camellia dieback (Glomerella cingulata) was controlled by benomyl applied as a foliage spray, mixed in the growing media, or added to the growing media as a drench. Azalea root and crown rots (Phytophthora spp.) were controlled by drenching with pyroxychlor drenches after transplanting into infested media. Pyroxychlor as a foliage spray was ineffective. A root and crown rot of shore juniper was found caused by Phytophthora spp. but not Pythium spp. or Rhizoctonia sp. Control was obtained by Pyroxychlor drenches.

Juniper blight

Little practical value was found in spraying with systemic fungicides or mixing them in the growing media to control juniper blight (Phomopsis juniperovae). Systemic fungicides in the seed bed did not control Arizona cypress blight (Cercospora thujina).

Dieback of holly

A new serious twig dieback of Ilex crenata rotundifolia was found to be caused by Phytophthora sp. Downy mildew of roses was found in Georgia for the first time and caused heavy losses in some varieties.

Maple blight

An abnormal condition on red maples thought to be a disease has been tentatively attributed to a herbicide inappropriately used on maples.

Rose viruses

Attempts to demonstrate transmission of Prunus Ringspot Virus via pollen transfer to rose flowers failed.

A new virus disease of rhododendron

A necrotic ring pattern on leaves of several cultivars of rhododendrons appears now to be caused by a virus. This idea is supported by recent electron microscope photos of flexuous rod virus-like particles in plants showing symptoms. Also, the causal agent was graft-transmitted from an infected rhododendron to Kalmia latifolia where symptoms appeared within 2 months. Attempts to mechanically transmit the causal agent to 21 herbaceous hosts failed.

NRP Annual Report
FY 1976

NRP 20040 Breeding and Production--Corn, Sorghum and Millets

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This program is a part of the USDA-ARS Mission on Agricultural Production Efficiency with the goal of producing new knowledge to increase productivity. To a lesser degree the program contributes to Mission 3 - Agricultural Marketing and Distribution and Mission 10 - Foreign Agricultural Development. The program is organized under two technological objectives.

TO 1

New and improved genetic populations, breeding lines, and hybrids of corn, sorghum and millets that combine improved yield potentials and favored quality characters, including reduced contents of undesirable constituents, with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting, and handling. Develop basic genetic, cyto-genetic, physiologic, and biochemical knowledge necessary to accomplish these goals.

TO 2

New and improved cultural and management practices that increase corn, sorghum and millet yields, minimize production losses, improve quality attributes, and conserve and use scarce resources efficiently.

SELECTED EXAMPLES OF PROGRESS:

Corn

Efforts to Reduce Genetic Vulnerability

The severe epidemic of southern corn leaf blight in 1970 brought to the attention of corn producers and breeders the very vulnerable situation with this crop. Since that time several studies have highlighted the genetic vulnerability of most of our important cultivated crops.

ARS breeders in cooperation with State Experiment Stations have been instrumental in developing and releasing 37 new inbred lines of corn and 8 broad-based breeding populations (see Appendix 1). These recent releases add considerably to the breadth of breeding material available to both public and private breeders. A number of these releases have been selected specifically for their resistance to one or more specific pest problems and for broad genetic base.

Several agronomic characteristics in addition to grain yield were evaluated in 288 exotic racial collections of corn. Some groups of races showed reasonably good breeding potentials for yield and other desirable traits. These exotic collections are being extensively evaluated for their reaction to a number of pests in the Southern and North Central Regions. Most of these collections have been introduced from Mexico, Central America, and South American countries. Breeding procedures to incorporate this broad genetic base material into usable, agronomic strains are underway at a number of locations, such as North Carolina, Georgia, Mississippi, Texas, Missouri, Iowa, and Ohio.

The use of varietal mixtures or mixtures of hybrids for planting the commercial fields of grain crops has been tested previously. The use of such mixtures would be one alternative to the vulnerability of a single hybrid or variety planted on an extensive field basis. Work at North Carolina has been conducted on the feasibility of predicting the performance of such mixtures, based on the performance of the component hybrids in pure stands.

Developing Breeding Systems

Because of the increase in the use of single cross hybrids, the rate of inbreeding in developing of parent lines has been under study (Iowa and North Carolina). Inbreeding systems allowing different rates of inbreeding during the development of the inbred lines were investigated, such as continuous selfing, continuous full sibbing and combination of full sibbing and selfing. The rate of inbreeding depression was similar for each of the systems of inbreeding. Selection within the system seems to be more important for vigor of final inbred line than the inbreeding system. Variability around the mean level of inbreeding was significant in a preponderance of the inbred pedigrees in every set for the traits evaluated.

Comparisons of 160 inbred lines and their performance in single cross hybrids indicated no strong correlation between the performance of inbreds and their hybrids, suggesting that hybrid performance is the only means of evaluating accurately the potential worth of the inbred lines (Iowa).

Corn production in the southern states is hampered by disease and insect pests. Work is centered on host plant resistance and the development of strains with resistance to several pests is underway at several locations, such as Mississippi and Georgia. While such work centers on plant breeding, strong cooperation is required from entomology and pathology. The combining of resistance to such pests

as southwestern corn borer, fall armyworm, corn earworm, southern rust, and maize dwarf mosaic virus into breeding strains is being accomplished in some releases of multiple resistance are indicated in Appendix 1.

Investigations on the mode of inheritance of resistance to pests are underway at a number of locations. Work at Ohio indicates that resistance to maize dwarf mosaic virus is controlled by a single dominant gene. Good correlations for percentages of diseased plants were obtained between strains of the virus and strains by inoculation method. Studies on the inheritance of resistance to downy mildew, southern corn rust, and southwestern corn borer indicate the transfer of the resistance is probably intermediate but further work is needed to identify the specific mode of gene action.

Comparisons of six quantitative traits at different plant densities showed little differences in genetic variance estimates. However, the rankings of hybrids showed little agreement among densities indicating that testing should be done in different densities.

Selection for Special Morphological Characteristics

Fourteen inbreds were released from the Missouri program based on recurrent selections for crushing strength of the stalks (see Appendix 1). Some of these inbred lines have stalk strength nearly double that of the commercial hybrids. Four corn synthetic varieties have been converted to dwarf versions (brachytic 2). The dwarf versions have been selected for vigor of the dwarf plants and medium to large ear size (South Dakota). Selection work on the dwarf versions is continuing to evaluate yielding ability in the different population levels.

As part of the rootworm tolerance studies, 3 synthetic varieties have been evaluated for their root strength by pulling mature plants. A 12 percent gain in pulling resistance in the second cycle population of one synthetic has been predicted. Wide differences in root pulling resistance were shown to exist among 49 corn inbred lines. Resistance to root pulling is believed to be associated with tolerance to the corn rootworm damage.

Biochemical and Quantitative Genetic Research

Isozyme variants in numerous inbred lines and 90 racial collections of corn from Mexico and Central America were studied (North Carolina). Genetic control of several isozyme systems has been established. It appears that about 20 loci are involved in the expression of the isozyme variation observed. One enzyme which mediates the activation of DIMBOA is the compound which has been implicated in resistance to

European corn borer, Diplodia maydis and Helminthosporium turcicum. Statistical analyses showed that random variation (drift) was not adequate to explain the trends detected. Therefore, some type of directional selection must be invoked (North Carolina).

Studies on the types of gene action present in the synthetic BSSS indicated epistatic variance was not an important component of the genetic variance for yield. Additive genetic variance accounted for 93.2 percent of the total variability. The results indicate that the weighted least-squares procedure was an adequate method of estimation and much simpler to use than the maximum likelihood procedure (Iowa).

Plant colors governed by genes which synthesize various anthocyanins are enabling a very detailed study of the interactions between such factors and the biochemistry. Precise genetic control of the anthocyanin factors in various plant tissues is enabling a new look at the developmental process in such tissues (Missouri). Evidence obtained suggests that phenolic compounds have little effect on fungi which are parasitic on corn.

Cytogenetic Investigations

An improved procedure has been developed for preparing and staining very thin plastic sections of plant materials. This technique has made possible the study of closely paired series of fertile and sterile corn anthers at both light and electron microscope levels. Mitochondria in certain layers of sterile corn anthers begin to degenerate very early in the development of pollen grains. This degeneration of the organelles in the cells seems to be the cause of sterile pollen (Florida). The use of enzyme digestion of mitochondrial DNA and the use of electrophoresed gels allow the measurements of differences in corn cytoplasms. This fingerprinting technique has demonstrated differences between the cytoplasms of normal and Texas male sterile cytoplasm. It has also indicated that different normal cytoplasms may also differ in their enzyme reaction, indicating differences which have not been demonstrated by other means. In these normal cytoplasms, if such is proven to be true, the vulnerability of the crop to various pests may not be as great as assumed if all normal cytoplasms of corn were identical.

Detailed studies have shown the pattern of development of the endosperm in seed is established at the first several cell divisions which are systematically oriented and that the terminal divisions are equally systematic.

Grain Quality Investigations

The grain quality and quantity of protein found in cereal grains receives a great deal of attention. Biochemical and breeding work is underway at a number of locations (Maryland, Kansas, Illinois, Iowa, North Carolina, Missouri). Selection to modify the soft kernel characteristics of opaque-2 corn has been possible. A selection for hard kernel modifications of opaque-2 improves the general quality of the grain but care must be taken to maintain the level of lysine which is the main advantage in growing opaque-2 corns. Selection for improved germinability of opaque populations has also been successful in improving the germinability of the modified populations. Selection for lysine content in normal dent corn varieties has shown that lysine content can be increased by selection and recombination to the level of that found in the opaque-2 corn. Three cycles of selection and recombination have succeeded in producing normal starch kernels with good levels of lysine.

Studies are underway to determine the inheritance of soluble protein factors. The high quality soluble proteins are characteristically increased in opaque-2 varieties. Work has shown a second major soluble protein with similar properties is present in the line Oh45B opaque-2 (Illinois).

Studies are underway to compare the lipids of corn leaves and roots with those found in the grain. Each lipid class has a characteristic fatty acid pattern according to its location in leaf, root, germ or endosperm, but a general overall effect is exerted on the unsaturation of the fatty acids by the genotype of the plant (Illinois).

Achievements in Host Plant Resistance to Pests

Aflatoxin was found in preharvest corn. At many different locations in the U.S. levels of aflatoxin appeared to be higher for early-planted corn or early-maturing corn grown in areas where it was not adapted. In addition, insect damage and conditions of stress during late growing seasons seemed to enhance aflatoxin. Hybrids with the inbred parent SC76 appeared to have lower aflatoxin than other hybrids of the same maturity when grown at several locations in the U.S.

Attempts to add anthracnose resistance to susceptible inbreds have been temporarily stopped by the lack of satisfactory field inoculation techniques. Field monitoring of anthracnose in no-till fields indicate a high carryover of the disease organism on the residue left on the surface of the soil (North Carolina and Indiana). Hybrid combinations involving one or more resistant parents were more resistant to downy mildew than those combinations of susceptible parents.

The occurrence of southern corn rust has been relatively low during the past two seasons. Work continues on the screening of germplasm for resistance to this disease organism.

A breeding population OhS4 has been released which has been selected for tolerance to maize dwarf mosaic virus and maize chlorotic dwarf virus (Appendix 1). Studies on both corn viruses indicate that several genes are involved in resistance and their location on the chromosomes has been tentatively identified (Mississippi).

Selection for leaf feeding resistance to the southwestern corn borer has shown the selected population to be much less damaged than a susceptible check population after two cycles of recurrent selection (Mississippi).

Field measurements on the number of corn earworm larvae recovered from silks by select crosses indicated that selection progress for that character is possible. Progeny within several populations were screened for earworm injury and was recombined (Georgia).

No real plant resistance to rootworm feeding has been isolated. Breeding for corn lines capable of regenerating root growth following damage and large strong root systems appears to be the only approach for the breeder to offset the damage of these pests (South Dakota).

Pathological Research on Corn Pathogens

Studies of the effects of temperature in the pathogen for southern corn blight have shown the virulent race T to be more sensitive to temperature than the common race O. At high temperatures, both races sporulate at a high level; whereas, race T sporulates poorly at cooler temperatures (Indiana). In comparisons of isogenic lines of races O and T of Bipolaris (Helminthosporium) maydis, it was found that race T virulence is associated with a slight decrease in the virulence on corn with normal cytoplasm so that natural selection favors race O on normal cytoplasm and race T on cms-T corn (North Carolina).

Studies on the stability of MDMV resistance in some corn lines have shown that resistance may be altered by changing the environment, inoculation techniques, and titer of inoculum (Ohio).

Sorghum

Developing Breeding Systems

Two cycles of family testing with population NP3R have demonstrated significant increased gains each cycle, with the indication that S_1 progeny testing and full-sib family testing are equally effective and that both are more effective than half-sib family testing (Nebraska). Population breeding utilizing S_1 progeny testing has been successfully applied to develop greenbug resistance, increase corn borer resistance, and to increase grain protein. Mass selection screening under water stress in Arizona, using NP9BR population with recombination of selections in Nebraska, has shown reduction in yield under Nebraska compared to selections done in Nebraska.

Limited data with reciprocal full-sib crosses indicate heterotic effects when two populations (B and R) are crossed either in bulk or in paired crosses. Limitations on practical application of reciprocal recurrent selection are physical and mechanical rather than theoretical. Limited experimentation with topcrosses (population x inbred) suggest that they might be used for identification of lines having good, general combining ability (Nebraska).

Yield trials of isogenic single- and twin-seeded sorghum hybrids showed that twin-seed hybrids yielded less grain than single-seeded hybrids under Kansas conditions.

Cytogenetic and Genetic Investigations

Three male sterile lines were found to possess cytoplasms different from that of milo, the sterile-inducing cytoplasm now used to produce hybrids. One of these induces a high degree of sterility in some lines that cannot be sterilized in milo cytoplasm (Texas).

Apomictic seed formation was found in crosses of A lines x apomictic lines. The apomictic character is of considerable interest since, if it can be controlled, it would be a means of perpetuating sorghum hybrids.

Host Plant Resistance to Pest Organisms

Sorghum downy mildew resistant selections of sorghum-Sudangrass populations and of corn cultivars have been identified for use in breeding programs (Kansas and Texas).

Several instances of interrelationships between sugarcane mosaic virus-J and Fusarium moniliforme were noted in artificially induced root rot and head blight of sorghum under controlled conditions. These included greater visible damage and reduction in root and seed weights as well as greater fungal invasion of affected tissues (Kansas).

Random mating in populations to screen for downy mildew, greenbug, midge, and maize dwarf mosaic virus is under investigations (Nebraska and Kansas).

Progress in Physiological Research

Sorghum hybrids having one high heat tolerant parent and one low indicating that heat tolerance is dominant or partially dominant. A sub-injurious preheat treatment to sorghum increased the stability of photosynthesis to subsequent high temperatures which were injurious to untreated controls. However, the pretreated plants had reduced stomatal conductance at high temperatures resulting in lower CO₂ exchange.

Failure of sorghum stomata to open fully after one or more drought cycles was attributed to high leaf concentrations of ascorbic acid which remained for an extended period after plants were exposed to an initial drought stress (Nebraska).

The yield of 14 sorghum strains varied in reduction when grown under rain shelters to test for drought response. Yield reductions ranged from 18 to 56 percent compared to the controls. Sorghums that had been selected for cold tolerance were more affected by the drought stress. Sorghum lines grown in hydroponic cultures in slender cylinders showed marked differences in root to shoot ratios. These results agreed with previously found root development in root boxes and field soil water extraction profiles (Nebraska).

Sorghum hybrids grown on soils selected to be low in Fe and P showed wide differences in growth (dry-matter yield), in mineral element deficiency symptoms, and in Fe and P contents.

Top/root ratios of plants (corn) increased as P levels increased, and these increases in top/root ratios may be attributed partly to decreased root growth at the higher P levels. The P-efficient inbreds Pa36 had the ability to translocate greater proportions of P to the tops compared to the amount that remained in the roots than the P-inefficient inbred, WH (Nebraska).

Millet

An S₁ grain yield trial was conducted with Manhattan pearl millet population (Appendix 1) and the high yielding S₁ lines were recombined in Puerto Rico. Two hundred plants of a Senegal pearl millet population were selfed for further evaluation. Both pearl millet populations have looked promising under Kansas growing conditions.

Appendix 1

Releases of Germplasm Developments

<u>Corn</u>			
<u>Date</u>	<u>State</u>	<u>Designation</u>	<u>Description</u>
11-75	OH-IA	OhS3(S)C1	Europ. borer, H. turcicum, MDMV, MCDV yield
6-75	NC	NC 242 inbred	good in NC 7417
		" 244 "	anthracnose res, high yield
		" 246 "	good in NC 7417
		" 248 "	" " "
3-75	IA	B79	2-eared, turcicum res., Eu. borer res.
2-75	IN	B37Rpp9	res. to southern rust Puccinia polysora
		Oh43Rpp9	"
		W64ARpp9	"
		H55Rpp9	"
3-75	MS	MpSWCB-1	res. to SWCB, 1st brood
		MpSWCB-2	"
		MpSWCB-3	"
3-75	MO	PR-Mo2	Caribbean, Central Am. and Mexican
1-75	GA	GT201 wx to GT210 wx	waxy endosperm southern inbreds
5-76	OH	Oh517	res. to northern, southern and bacterial leaf blight
		Oh561	earlier than B37, med. res. to leaf blights
		OH562	"
		OH563	"
4-76	MO	MO26W	white, strong stalk line
		MO27W	"
		MO28W	"
		MO29W	" strong
		MO30W	" very strong
		MO31W	" strong
		MO32W	"
		MO33W	"
		MO34	yellow, strong stalk line very strong
		MO35	" "
		MO36	" strong
		MO37	"
		MO38	" very strong
		MO39	"

Appendix 1 (cont'd.)

<u>Date</u>	<u>State</u>	<u>Designation</u>	<u>Description</u>
2-76	IA	BS19(S)C2 BS20(S)C2	early rootworm tolerant population late " " "
1-76	MS	MpSWCB-4	Southwestern borer res.
<u>Millet</u>			
7-75	KS	RMP1(S)C1 (population)	dwarf, good grain yield, greenbug res. Serere 3A and Serere 17xTift 239 random mating
<u>Sorghum</u>			
6-76	NB	RS455 hybr. M-A4 cms inbred	early maturity for CO, NB, SD, MN
5-76	NB	RP1R RP2B	wide-based R population, greenbug res. " B " " good grain quality
3-76	KS	KS-58 KS-59 KS-60 KS-61 KS-62 KS-63 KS-64	intermediate grain-forage.Wh.Martin x Sudan " " " " " "
1-76	NB	29 lines N1 to N29	seedling res. to greenbug, both B or R

Appendix 2

Selected Publications

Corn

Florida

Warmke, H. E. and Lee, S. L. J. Improved staining procedures for Semithin epoxy sections of plant tissues. Stain Technology 51:179-185. 1976

Levings, C. S., III and D. R. Pring. Restriction endonuclease analysis of mitochondrial DNA from normal and Texas cytoplasmic male-sterile maize. Science 193:158-170. 1976.

Georgia

Widstrom, N. W., B. R. Wiseman, and W. W. McMillian. Evaluation of selection potential for earworm resistance in two corn populations and their cross. Crop Sci. 15:183-184. 1976.

Widstrom, N. W., W. D. Hanson, and L. M. Redlinger. Inheritance of maize weevil resistance in maize. Crop Sci. 15:467-470. 1975.

Widstrom, N. W. Graphic interpretation of regressions of F_1 on midparents and the application to anomalous data. J. Heredity 67:54-58. 1976.

Wiseman, B. R., W. W. McMillian, and N. W. Widstrom. Wireworm resistance among corn inbreds. J. Ga. Ent. Soc. 11:58-59. 1976.

Wiseman, B. R., N. W. Widstrom, W. W. McMillian, and W. D. Perkins. Greenhouse evaluations of leaf-feeding resistance in corn to the corn earworm. J. Ga. Ent. Soc. 11:63-67. 1976.

Illinois

Stoller, E. W., and E. J. Weber. Differential cold tolerance, starch, sugar, protein, and lipid of yellow and purple nutsedge tubers. Plant Physiol. 55:589-563. 1975

Weber, E. J., and D. E. Alexander. Breeding for lipid composition in corn. J. Amer. Oil Chem. Soc. 52:370-373. 1975.

Wilson, C. M., and G. A. Apel. Effect of Helminthosporium maydis, Race T, Pathotoxin on growth and Ribonuclease levels of corn roots. Crop Science 15:385-389. 1975.

Wilson, C. M. Plant Nucleases. Ann. Rev. Plant Physiology 26:187-208. 1975.

Appendix 2 (cont'd.)

Indiana

Warren, H. L. Effect of inoculum concentration on resistance of lima beans to Rhizoctonia solani. Phytopathology 65:341-345. 1975.

Warren, H. L., D. M. Huber, D. W. Nelson and O. W. Mann. Stalk rot incidence and yield of corn as affected by inhibiting nitrification of fall-applied ammonium. Agronomy J. 67:655-660. 1975.

Warren, H. L. Temperature effects on lesion development and sporulation after infection by Races O and T of Bipolaris maydis. Phytopathology 65:623-626. 1975.

Warren, H. L. and R. L. Nicholson. Kernel infection, seedling blight and wilt of maize caused by Colletotrichum graminicola. Phytopathology 65:620-623. 1975.

Warren, H. L., R. L. Nicholson and M. T. Turner. Field reaction of corn inbreds to Colletotrichum graminicola. Plant Disease Reptr. 59:767-769. 1975.

Nicholson, R. L. and H. L. Warren. Criteria for evaluation of resistance to maize anthracnose. Phytopathology 66:86-90. 1976.

Iowa

Hallauer, A. R. Relation of gene action and type of tester in maize breeding procedures. Proc. 29th Ann. Corn and Sorghum Res. Conf. ASTA. 1975.

Hallauer, A. R. Inbred line and hybrid development from improved maize populations. EUCARPIA 8:1-35. 1975.

Hallauer, A. R. and Dustan Malithano. Evaluation of maize varieties for their potential as breeding populations. Euphytica 1:1-6. 1976.

Hallauer, A. R. and C. A. Martinson. Reaction of maize hybrids and inbreds to Bipolaris maydis, Race T, infection. Agron. J. 67:497-501. 1975.

Hallauer, A. R. and C. A. Martinson. Maternal effects detected in maize hybrids infected with Helminthosporium maydis, Race T. Crop Sci. 15:686-671. 1975.

Hoegemeyer, T. C. and A. R. Hallauer. Selection among and within full-sib families to develop single crosses of maize. Crop Sci. 16:-76-81. 1976.

Loesch, P. J., Jr., D. C. Foley, and C. Cox. Comparative resistance of opaque-2 and normal inbred lines of maize to ear rotting pathogens. Crop Sci. (In press). 1976

Appendix 2 (cont'd.)

Iowa (cont'd.)

Martin, J. M. and A. R. Hallauer. Relation between heterozygosis and yield for four types of maize inbred lines. Egyptian J. Gen. and Cytol. 5:119-135. 1976.

Russell, W. A. and A. R. Hallauer. Registration of B79 parental line of maize (Zea mays L.). Crop Sci. 16: (accepted for publication). 1976.

Silva, Jose Carlos and A. R. Hallauer. Estimation of epistatic variance in Iowa Stiff Stalk Synthetic variety of maize (Zea mays L.). J. Heredity 66:290-296. 1975.

Mississippi

Futrell, M. C. Puccinia polysora epidemics on maize associated with cropping practice and genetic homogeneity. Phytopathology 65:1040-1042. 1975.

Futrell, M. C., A. L. Hooker, and G. E. Scott. Resistance in maize to corn rust controlled by a single dominant gene. Crop Sci. 15:597-599. 1975.

Lunsford, J. N., M. C. Futrell, and G. E. Scott. Maternal effects and type of gene action conditioning resistance to Fusarium moniliforme seedling blight in maize. Crop Sci. 16:105-107. 1976.

Missouri

Neuffer, M. G. and E. H. Coe, Jr. Linkage map and annotated list of genetic markers in maize. In Vol. II of Handbook of Biochemistry and Molecular Biology, 3rd edition, G. D. Fasman, editor. CRC Press, Cleveland, Ohio. pp. 833-847.

Coe, E. H., Jr. The aleurone tissue as a genetic tool. Invitational paper, Internatl. Maize Symposium: Genetics and Breeding 1975, Sept. 10, 1975.

Zuber, M. S., W. H. Skrdla, and Bong-Ho Choe. Survey of maize selections for endosperm lysine content. Crop. Sci. 15:93-94. 1975.

Lillehoj, E. B., W. F. Kwolek, E. E. Vandegraft, M. S. Zuber, O. H. Calvert, N. W. Widstrom, M. C. Futrell, and A. J. Bockholt. Aflatoxin production in Aspergillus flavus inoculated ears of corn grown at diverse locations. Crop Sci. 15:267-270. 1975.

Cloninger, F. D., R. D. Horrocks, and M. S. Zuber. Effects of harvest date, plant density, and hybrid on corn grain quality. Agron. J. 67:693-695. 1975.

Egharevga, P. N., R. D. Horrocks, and M. S. Zuber. Dry matter accumulation in maize in response to defoliation. Agron. J. 68: 40-43. 1976.

Choe, B. H., M. S. Zuber, G. F. Krause, and E. S. Hilderbrand. Inheritance of high lysine in maize. Crop Sci. 16:34-38. 1976.

Appendix 2 (cont'd.)

North Carolina

Leonard, K. J. Isolation of Bipolaris maydis race 0 from corn seed harvested in 1965. Plant Disease Rptr 60:245-247. 1976

Julis, A. J., K. J. Leonard, and R. H. Moll. The effect of C and S group cytoplasms on resistance to southern corn leaf blight. Phytopathology 66:336-341. 1976.

Leonard, K. J. and D. L. Thompson. Effects of temperature and host maturity on lesion development of Collectotrichum graminicola on corn. Phthopathology 66:635-639. 1976.

Maxwell, J. D. and D. L. Thompson. Mutual balance between tester resistance and isolate virulence in the evaluation of corn inbreds for Diplodia stalk rot. Crop Sci. 14:594-595. 1974.

Moll, R. H., C. W. Stuber, and W. D. Hanson. Correlated responses and responses to index selection involving yield and ear height of maize. Crop Sci. 15:243-248. 1975.

Stuber, C. W. and M. M. Goodman. B-glucosidase isozyme variation in maize races. Isozyme Bulletin 9:59. 1976.

Ohio

Gingery, R. E. Influence of pH and divalent anions on the buoyant density of maize dwarf mosaic virus in CsCl. J. gen. Virol. 31, accepted for publication - October 8, 1976.

Gingery, R. E. Properties of maize chlorotic dwarf virus and its ribonucleic acid. Virology, accepted for publication - March 4, 1976.

Louie, R. and J. K. Knoke. Strains of maize dwarf mosaic virus. Plant Dis. Reprtr. 59:518-522. 1975.

Louie, R., W. R. Findley, and J. K. Knoke. Variation in resistance within corn inbred lines to infection by maize dwarf mosaic virus. Submitted to Plant Dis. Reprtr. 1976.

Sorghum

Kansas

Campbell, L. G., A. J. Casady, and W. J. Crook. Effects of a single height gene (DW₃) of sorghum on certain agronomic characters. Crop Sci. 15:595-597. 1975.

Appendix 2 (cont'd.)

Kansas (cont'd.)

Casady, A. J. Inheritance of purple testa in sorghum. J. Hered. 66:180. 1975.

Lash, L. D. and L. K. Edmunds. Use of Chloramphenicol in modified Nash-Snyder medium for controlling bacteria on soil-dilution plates. Proc. Amer. Phytopath. Soc. 2:27. 1975

Liang, G. H., A. D. Dayton, C. C. Chu, and A. J. Casady. Heritability of stomatal density and distribution on leaves of grain sorghum. Crop Sci. 15:567-570. 1975

Nebraska

Hackerott, H. L., T. L. Harvey, and W. M. Ross. Registration of KP6BR germplasm. Crop Sci. 16 (1976): In press.

Kofoed, K. D., W. M. Ross, H. L. Hackerott, T. L. Harvey, and S. D. Kindler. Evaluation of greenbug resistance in S₂ progenies of grain sorghum. Crop Sci. 16 (1976):265-267.

Ross, W. M. Sorghum. In Atlas of Nebraska Agriculture. D. Murfield and J. H. Williams (Ed.). Univ. of Neb. Press (1976):44-47.

Wall, J. S. and W. M. Ross. (Ed.) Produccion y usos del sorgo. Editorial Hemisferio Sur. Buenos Aires (1975), 399 p.

Sullivan, C. Y. A comparison of sorghum and corn in controlling water loss and in tolerance to desiccation and heat stress. In Biophysical Control of Water Loss. Report to the Office of Water Resources Research. (1975):1-11.

Sullivan, C. Y. Root studies in relation to water use. Ibid. p. 12-16.

Sullivan, C. Y., V. B. Ogunlela, W. M. Ross, and J. D. Eastin. Selecting for heat and desiccation tolerance in field-grown sorghums. Ibid. p.16-24.

Norcio, N. V. and C. Y. Sullivan. Effect of high temperatures on the rate of photosynthesis and respiration of some sorghum and corn genotypes. Ibid. p. 28-32.

Clark, R. B. Differential magnesium efficiency in corn inbreds. I. Dry-matter yields and mineral element composition. Soil Sci. Soc. Amer. Proc. 39:488-491. 1975.

Clark, R. B. Characterization of phosphatase of intact maize roots. J. Agr. Food Chem. 23:458-460. 1975.

Appendix 2 (cont'd.)

Nebraska (cont'd.)

Clark, R. B. Mineral element concentration in corn leaves by position on the plant and age. Comm. Soil Sci. Plant Anal. 6:439-450. 1975.

Clark, R. B. Mineral element concentration of corn plant parts with age. Comm. Soil Sci. Plant Anal. 6:451-464. 1975

Texas

Henzell, R. G., K. J. McCree, C. H. M. Van Bavel, and K. F. Schertz. Method of screening sorghum genotypes for stomatal sensitivity to water defects. Crop Sci. 15:516-518. 1975.

Craig, J. An inoculation technique identifying resistance to sorghum downy mildew. Plant Dis. Rept. 60:350-352. 1976

Craig, J., O. J. Webster and M. S. Zuber. Registration of PR-Mo2 maize germplasm. (Accepted by Crop Sci. for publication January 16, 1976)

Craig, J., G. E. Scott, G. F. Sprague, and O. J. Webster. Registration of PR-Mp1 and PR Mp4 maize germplasms. (Accepted by Crop Sci. for publication May 7, 1976)

NRP Annual Report
FY 1976

NRP 20050 Breeding and Production--Small Grains (Wheat, Oats, Barley, Rice, Rye, Triticale, Wild Rice, Buckwheat)

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TO 1 New and improved genetic populations, breeding lines, and varieties of small grains that combine greater yield potentials and favored quality characters, including reduced contents of undesirable constituents, with better resistance to pests, tolerance to environmental stress, responsiveness to new cultural and management practices, and adaptation for mechanized culture, harvesting, and handling.

TO 2 New and improved cultural and management practices that increase small grain yields through disease, insect, and weed control; that minimize environmental stress; that improve physical and nutritional quality attributes; that minimize production losses; and that conserve and more efficiently use scarce or irreplaceable resources.

EXAMPLES OF PROGRESS:

Small Grains in General

Seed Increase

Over 15,000 single-row plots and about 9,200 spaced plants and hills of wheat, oats, and barley were grown for 21 ARS and SAES projects in 13 States in 1975. This included propagation material from the World Collections of wheat, oats, and barley, as well as from the International Rust Nurseries. Over 4,000 hills of wild oats (Avena fatua) were increased (Aberdeen, Idaho).

Varietal Development

Twelve wheat, three oat, one barley, and four rice varieties were released cooperatively by ARS and the State Agricultural Experiment Stations in the calendar years 1975-76 (Appendix 1).

Seven wheat, two oat, and two barley germplasm populations were released by the same agencies during the same period (Appendix 2).

Physiology of Winterhardiness

Basic research directed toward the understanding of winterhardiness in small grains indicates that various hydrophilic proteins and carbohydrates associate with cell membranes as plants harden. Some prevent direct adhesion between ice and the membrane. Cell wall xylans previously identified in an analysis of freezing kinetics as natural protectants against crystallization energy also protect against adhesions. They precipitate as ice from plant structures.

Toxins produced in degenerating tissue the first few days after thawing and pathogenicity of facultative parasites were found to cause secondary spread of frost lesions in winter cereals, and this greatly affected recovery from winter injury (East Lansing, Michigan).

Special Nurseries

Five international disease nurseries were prepared in 1975 and sent to 41 countries. Two nurseries were grown in Puerto Rico.

A total of 320 varieties of small grains, grasses, and legumes, reported resistant or tolerant to oat cyst nematode, were grown in cooperation with the Oregon AES for direct testing with nematodes found in that area. Fall planted entries were not seriously damaged, but female nematodes were observed on roots and in soil. Spring-planted entries were stunted and root systems damaged. Roots contained numerous female nematodes. None of the cereals were immune (except sweet corn). About 40 cereal entries supported development of only a few cysts and may be resistant.

Wheat

Wheat Breeding and Genetics

Multiline wheat varieties offer excellent potential for the control of stripe rust. Four new virulent races of stripe rust have evolved in the last four years in the Pacific Northwest. Four years of tests with two multiline varieties have given excellent stripe rust control with good yields. The multilines have 6 to 11 component lines, each with a different source of stripe rust resistance. Blended together these mixed forms of resistance curtail crop disease loss by diluting the effect of new virulent races in buffering disease damage and spread within the multiline (Pullman, Washington).

Semidwarf varieties are now grown on from 75 to 90 percent of the total wheat acreage in California, Idaho, and Washington. Some improvements have been made in time of emergence and stand establishment with semi-dwarf wheats. Disease loss from stripe rust, flag smut, and dwarf bunt seems to be greater in semidwarfs than in standard type varieties.

Resistance to wheat streak mosaic virus from Agropyron and resistance to greenbug from rye have been transferred to common wheat. Resistant progenies are being field and greenhouse tested and are now in the Oklahoma varietal development program (Stillwater, Oklahoma).

Breeding efforts directed toward higher level of protein in wheat grain are underway in Lincoln, Nebraska, Pullman, Washington, and Bozeman, Montana. The first high protein HRW wheat released was 'Lancota' in 1975. Lines which are more highly productive and higher in protein are now in the ARS-Nebraska program. Slightly higher lysine has been identified from derivatives of Nap Hal x C.I. 13449.

The genetic complement for stem rust resistance of Waldron HRS wheat and for Ward and Rugby durums has been determined. Many crosses are underway to determine the genetic complement of other varieties (Fargo, North Dakota).

M3 generation plant materials were produced for testing effectiveness of ethylmethane sulfonate in inducing mutations of several quantitative characters (Fargo, North Dakota).

Each of two genes provide resistance to all known races of common bunt. One produces a higher level of resistance than the other. New sources of resistance to both common and dwarf bunt occur in the new group of Triticum monococcum and Triticum timopheevi introductions (Corvallis, Oregon).

New primary hexaploid and octaploid triticales lines were produced and used in crosses with hexaploid triticales to broaden the germplasm base. Acceptable semidwarf lines in the program have improved self-fertility, seed quality, and are resistant to stripe rust and are winterhardy (Corvallis, Oregon).

The first stages of an attempt to transfer stem rust resistance from Triticum speltoides to common wheat without the character for adherence of the glumes seem successful. A few resistant progenies were recovered which did not have adhering glumes, but did have resistance to stem rust.

All telocentric chromosomes have been obtained except for 7DL. Efforts are underway to obtain that one (Columbia, Missouri).

A 1D(1A) disomic substitution line of Langdon durum with improved dough strength as measured by a mixograph has been produced--also a 5D disomic addition line of Langdon durum. A set of monosomic D genome substitution lines in Langdon has been completed. It showed that the addition to durum of a pair of 1D chromosomes from Chinese spring wheat resulted in no change in amino acid balance, but an increase in loaf volume and better crumb grain and texture occurred (Fargo, North Dakota).

Semidwarf genes sd_1 and sd_2 were transferred to durum from the winter wheat lines, Gaines Sib and another. These genetic stocks will be used as testers to determine what durum lines or varieties carry which semidwarf genes (Fargo, North Dakota).

Diseases

Approximately 16,000 wheats were inoculated with virulent cultures of stem rust, Puccinia graminis tritici (Beltsville, Maryland).

Wheat seed known to be infected with barley stripe mosaic virus and stored since 1956 and 1961 was evaluated in fields in 1975. The virus was still viable and caused severe yield loss (Bozeman, Montana).

Five thousand wheats from the World Wheat Collection were tested for reaction to pathogenic cultures of the wheat powdery mildew pathogen (Beltsville, Maryland).

Wheat and triticale varieties were inoculated with barley yellow dwarf virus in the fall of 1974 and spring of 1975. Fall and spring infection each resulted in a 25 percent yield reduction (Brookings, South Dakota).

Probabilities of stem rust epidemics occurring in specific crop reporting areas of the Great Plains were determined based on inoculum source, virulence and avirulence of parasite populations, tolerance of varieties to a certain level of the disease, favorable or unfavorable environment for disease development, and deviations from average weather patterns in crop phenology (Manhattan, Kansas).

Aerial application of fungicides effective against leaf rust and stem rust resulted in from 2 to 38 percent increase in yield, providing timely application of fungicide was made using the forecast of epidemic development (Manhattan, Kansas).

Presently grown hard red winter wheat varieties with LR24 show a continuing trend toward susceptibility due to an increase of genotypes of leaf rust that can attack lines with LR24. A method of depicting pathogenicity in Puccinia recondita, based on a population genetic approach rather than a taxonomic approach, was developed. This involves an attempt to acquire specific combinations of genes in the host for low reaction as a more permanent means for protection against the ravages of leaf rust (Manhattan, Kansas).

Foliar infection by Septoria tritici reduced root growth of 54 day old winter wheat plants in resistant and susceptible varieties by more than 50 percent in greenhouse tests. Susceptible Triumph 64 was a significantly more efficient substrate for inoculum production of Septoria tritici than moderately resistant Tam 101 and resistant Oasis. This supports the general contention that pycnidia production is a valid index of host resistance (Stillwater, Oklahoma).

Artificial inoculation with stem rust of susceptible spring wheat lines indicated that rate of rust development varied among them (Stillwater, Oklahoma).

Resistance to Fusarium foot rot is expressed after infection. All varieties seem to be infected by the time they tiller. Losses from Fusarium foot rot are now greatly reduced by use of Luke and Sprague varieties combined with lower rates of nitrogen application.

Stubble mulching can be applied for erosion control with little concern for foot rot. Cercosperella foot rot was more severe in mold board plowed than stubble mulched plots. Yields were reduced by stubble mulching, but not because of foot rot.

Soil from the tillage layer in Pacific Northwest fields produced three times more ethylene when incubated in the lab than did soil from 8 to 16 inches deep. Soil from straw mulched fields produced three times more ethylene than did soil from just beneath the residue layer of no-till fields. Ethylene production must be associated with organic residues mixed in soil (Pullman, Washington).

New dwarf bunt races that can attack varieties deriving resistance from P.I. 178383, widely used source of resistance, were identified from diverse areas of the Northwest. These races can attack all varieties recently released as resistant to dwarf bunt. We do have wheats from the World Collection which are resistant to all or nearly all known bunt races.

Excellent control of dwarf bunt by integrated use of resistant varieties and seed treatment with thiobendazole was obtained (Logan, Utah).

Several seed treatment fungicides continue to show efficacy against seed-borne and soilborne common bunt (Logan, Utah).

The endogenous germination inhibitor from uredospores of the stripe rust fungus, Puccinia striiformis, was identified as methyl cis 3,4 dimethoxycinnamate. The inhibitor was extracted from field collected spores and purified by several types of chromatography (Corvallis, Oregon).

Teliospores of the dwarf bunt fungus, Tilletia controversa, were collected from field infected wheat plants. Germination inhibitors were extracted from the spores, purified by column chromatography, and bioassayed with spores of the common bunt fungus, T. caries. Five strongly inhibitory zones were detected. Identification of the self-inhibitors should lead to the development of a highly specific and effective multi-inhibitor preparation to better control bunt diseases of wheat.

Transport of dwarf bunt spores in wheat shipments from one country to another is of great concern. Morphology of dwarf bunt, common bunt, and some grass smut teliospores is similar, when using either the light microscope or the scanning electronmicroscope. Four new sensitive chemical tests were developed to distinguish each spore type (Corvallis, Oregon).

Tests to control Septoria nodorum (glume blotch) of wheat revealed that 3 applications of Benlate reduced glume blotch 36 percent and 6 applications reduced it 78 percent. A slight delay in senescence was noted at both treatment levels. Growth regulator-fungicidal effects show promise of increasing wheat yields (Gainesville, Florida).

Grain Quality

One thousand three hundred ninety (1,390) samples of early generation material were screened for protein concentration. Seven hundred seventy (770) samples of early generation progenies were micro-milled and evaluated for quality. Three hundred ten (310) large samples (1,500 grams) of promising lines and recently released varieties were evaluated for functional properties, including kernel texture, bolting properties, flour yield, flour ash, dough mixing, oxidation, water requirements, and loaf characteristics. Some of these lines will be tomorrow's varieties. A number of them had high protein (Manhattan, Kansas).

Cereal malts were used in a no-sugar formula to hydrolize starch into fermentable sugars. Loaves of bread after 70 minutes of fermentation were indistinguishable in volume, appearance, or flavor from those that received 180 minutes. Replacing 16 percent wheat flour with high protein supplements increased protein 50 percent. Lysine was tripled which enhanced biological value of the protein (Manhattan, Kansas).

Higher incidence of coronary heart disease, diabetes, and some colon diseases in western countries is linked by some medical researchers to low fiber diets. Acceptable bread was produced when up to 7 percent of wheat flour was replaced by microcrystalline cellulose or wheat bran. More than 7 percent cellulose impaired loaf volume and other baking properties (Manhattan, Kansas).

Quality evaluation tests were performed on 1,068 hard red spring samples from 8 States, 581 samples of durum, 115 special samples, and 25 Crop Quality Council samples (Fargo, North Dakota).

An extended pilot mill flow was developed using impact mills which increased flour extraction by 5.6 percent, and improved the nutritional value of the flour without appreciably changing bread-baking quality (Fargo, North Dakota).

A frozen bread dough formula and baking procedure was developed which was designed to be used in the food trials at the Human Nutrition Lab at Grand Forks. This enables subjects being tested to have freshly baked bread each day. The formula will carry a 25 percent substitution of flour with fibrous material for fiber studies planned (Fargo, North Dakota).

Milling and baking quality of 815 progenies from preliminary and advanced nurseries were evaluated. Five thousand Ninety-Six (5,096) early generation selections were evaluated by semi-micro milling. Nine advanced selections from Washington, Idaho, and Utah were evaluated through large-scale milling tests. Subsamples of these went to the milling industry collaborators, including Japan and Korean laboratories. This cooperative project should influence export of our different types of bread (Pullman, Washington).

A total of 1,103 drill plot and advanced nursery samples were evaluated, plus 69 composited uniform nursery entries from 14 States; 2,556 early generation and micro-testing samples were also evaluated (Wooster, Ohio).

In a cooperative experiment several double-cropping and relay cropping techniques resulted in lower yields, but with no loss in milling or baking quality. In an herbicide experiment, preplant incorporation, pre-emergence, or post-emergence applications for weed control, likewise did not affect quality of the grain. However, spring application at the onset of rapid growth did cause some decrease in quality, especially at higher levels of herbicide (Fargo, North Dakota).

A density-gradient, nonaqueous fractionation technique for previously hexane extracted and pin-milled flour has been developed. This avoids chemical and physical changes in flour usually associated with aqueous fractionation. Fractions with protein contents ranging from 75 percent to 1 percent have been separated. Hard and soft wheat flours differed in fraction separation patterns. Brewers spent grain was added to wheat flour to improve the nutritional property of baked products by increasing protein for dietary fiber. Satisfactory cookies were obtained when surfactants were used. To a lesser extent layer cake tolerated additions of brewers spent grain in the presence of extra emulsifiers (Wooster, Ohio).

Oats

Breeding and Genetics

Semidwarf oat lines under development had improved winterhardiness, but even greater winterhardiness is needed. Susceptibility to Helminthosporium avena and Septoria avena is a barrier to utilization of semidwarf lines. Preliminary results indicate that wild oats (Avena sterilis, A. fatua, and A. ludoviciana) possess useful divergent genes for winterhardiness (University Park, Pennsylvania).

Two semidwarf oat lines were tested at 20, 60, and 100 pounds of nitrogen per acre. There was no lodging associated with nitrogen treatments, but a linear increase in grain and straw yields occurred. Increased tillering contributed more to increased straw yield than did culm elongation. There was no elongation of the lower three internodes in response to the nitrogen applied. Grain yields increased from 42 bushels per acre at 20 pounds nitrogen to 82 pounds per acre at 100 pounds nitrogen. Straw yield increased from 2,800 pounds per acre at 20 pounds of nitrogen to 6,000 pounds per acre at the 100 pound nitrogen level (University Park, Pennsylvania).

Diseases

Testing of spring oats and winter wheat for disease resistance identified a number of potential new sources of resistance to barley yellow dwarf virus, crown rust, oat smut, and soilborne wheat mosaic. Higher rates of transmission and more severe symptoms of barley yellow dwarf infection were associated Rhopalosiphum padi than with Macrosiphum avenae in oats and barley. In a virus-host-vector relationship study, particle morphology and histopathology of the oat striate mosaic virus indicate that it may be one of the largest of the rhabdoviruses infecting Gramineae (Urbana, Illinois).

Results from studies of horizontal resistance of Red Rustproof oats indicate that this is a combination of slow-rusting and late-rusting. A severe crown rust epidemic would not occur in oats with this resistance. Under ordinary spore loads, varieties with horizontal resistance develop far fewer pustules than do susceptible varieties. Under light spore loads, horizontal resistant varieties may not develop any pustules. High spore concentrations are required to alter the horizontal type resistance (Gainesville, Florida).

Grain Quality

A high-protein Avena sterilis derivative had greater quantities of globulin and glutelin protein fractions throughout groat development than Noble oats. Over 50 percent of total protein recovered was globulin, whereas albumins and prolamins accounted for less than 20 percent each at maturity.

Three amino acids, serine, lysine, and leucine were transported in phloem from a mature leaf source to an immature leaf sink at rates between 1.2 and 1.8 centimeters per minute.

Cell-free synthesis of protein, tentatively identified as globulin, has been achieved by translating polyribosomes extracted from developing oat groats with wheat germ supernatant (Madison, Wisconsin).

Twelve lipid components were identified and measured quantitatively in oat groats and in the embryonic axis, scutellum, bran and endosperm of groats. Triglycerides accounted for 41 percent of total lipids. Variation in fatty acid composition was measured among 15 oat varieties grown for 2 years at 3 locations. Variation was pronounced among varieties only (Madison, Wisconsin).

From October 1, 1975 to May 1, 1976, 21,239 oat samples were analyzed for protein concentration (Madison, Wisconsin).

In grain quality research, bushel weight (long time measure of grain quality) was not closely related to digestible energy. Characteristics more closely associated with digestible energy were percent fiber and percent groats (University Park, Pennsylvania).

Barley

Breeding and Genetics

Klages barley will be licensed in 1977 for production in Canada as a two-row malting variety. It is highly productive and a good malting quality barley. It was released by ARS and the Idaho Agricultural Experiment Station in 1973 and has gained acceptance as a good quality malting barley in Canada as well as in the U.S. (Aberdeen, Idaho).

A large number of composite crosses have been made in a continuing effort to develop winter barley varieties with superior winterhardiness. Winter survival of composite bulks was high in 1975 in South Dakota. An attempt will be made to determine the effect of deep-setting crowns on winter survival (Brookings, South Dakota).

Oil content of approximately 17,000 World Collection barleys ranged from 1.0 to 4.2 percent. Efforts are underway to increase the oil content of barley to 5.0 to 5.5 percent for the purpose of improving feed quality. One hundred eighty (180) of the highest oil lines will be retested (Brookings, South Dakota).

Some barley varieties are resistant to ergot if fertilized while others remain susceptible several days after fertilization. It is important in selecting female parents that are suitable for hybrid barley production to have this type of information (Bozeman, Montana).

Chemical gametocides produced up to 83 percent sterility in sprayed barley plots, but side effects were drastic and required heavy rates. More efficient chemicals with fewer side effects are needed (Bozeman, Montana).

Over 200 lines of barley have been identified which show tolerance to aluminum and/or acid soils. Combining sources is underway through use of male sterile stocks to increase the level of tolerance (Tucson, Arizona).

Male-sterile facilitated recurrent selection programs are underway to develop germplasm stocks for improved: (1) short straw, (2) high tiller number, (3) high number seeds per spike, (4) larger seed, and (5) earliness. Crosses are made in Arizona, F_1 's grown in Montana, and the

F₂ grown back in Arizona for the next cycle of crossing. Three lines balanced for both a seedling lethal character and msg2 (gene for male sterility) have been established in tertiary trisomic form for possible use in hybrid barley. Balanced tertiary trisomics can be used to locate the position of translocation break points and genes on chromosomes (Tucson, Arizona).

Diseases

The host-virus genetic system involving barley and barley stripe mosaic virus is very complex. In 12 strains of the virus, no correlation was found among the number of RNA components and host range or virulence of strains, among strains with distinctive protein coats and host range or virulence, or among the number of RNA components and concentration of infectious virus. In the host an allelic series of genes for resistance is being used in development of resistant varieties. Continued field surveys and seed lot assays assure nearly complete absence of barley stripe mosaic virus in barley fields in North Dakota (Fargo, North Dakota).

About 4,000 new barley introductions were assayed for presence of barley stripe mosaic virus at Aberdeen, Idaho. More than 100 entries from the various parts of the world were infected. They will not be entered in the World Collection unless desirable for some character--then virus-free seed will be produced at Fargo. Twenty-four varieties of barley reported to have resistance to barley yellow dwarf were evaluated in the greenhouse and field at Fargo. Nine of the highly tolerant lines are being used by breeders (Fargo, North Dakota).

Hydroponically grown barley plants in the jointing stage, when infected with barley yellow dwarf virus, were reduced in total dry weight by 25 percent, and dry weight of roots was reduced by 66 percent. A yield reduction of 22 to 24 percent resulted when plants were inoculated with oat blue dwarf virus in seedling and joining stages, respectively. To date, we have no resistance to oat blue dwarf virus in barley. Genetic studies for resistance to barley stripe mosaic virus are underway (Fargo, North Dakota).

Grain Quality

Eight quality characters in malt and 5 for barley were determined for 3,000 barleys and 2,400 malts. A new micro-malting procedure for 50 gram samples of F₃ genetic material (early generation) was tested and found successful (Madison, Wisconsin).

Rice

Breeding and Genetics

Calrose 76, short straw mutants from irradiated Bonnet 73, and other short straw types are under study to provide more resistance to lodging (Stuttgart, Arkansas).

Calrose 76, a short stature variety released by the California Experiment Station and ARS, represents a distinct advance in lodging resistance. It is an induced mutation from the variety Calrose. This semidwarfing gene is at the same locus as the semidwarfing gene in IR8 (Davis, California).

A Hawaii winter nursery was used to screen for blanking (cold induced sterility). Seedling cold tolerance is very important for rice produced in California.

A second induced short stature mutant from Calrose has the semidwarfing gene at a different locus from that of Calrose 76 and IR8. A dwarfing gene has been obtained from a Chinese variety and there are 5 induced short mutants from India (nonallelic to IR8). Different sources are being accumulated to minimize genetic vulnerability in rice (Davis, California).

A winter performance nursery is grown in Puerto Rico for the purpose of advancing breeding lines more rapidly in the Louisiana and Texas programs (Beaumont, Texas).

Over 1,500 breederslines were screened for blast resistance, and 272 diseased specimens were processed. Two new races of blast, neither of which poses immediate threat to U.S. varieties, were observed. Inheritance studies indicate that blast resistance generally is simply inherited and is dominant. In some crosses, however, preliminary results suggest transgressive segregation for resistance and polygenic inheritance.

Blast was the most common rice disease in the South (Beaumont, Texas).

Grain Quality

During 1976, as a part of the National Rice Improvement Program, 3,811 breeding samples were evaluated for quality. Nearly all were submitted from Texas, Louisiana, Arkansas, and California (Beaumont, Texas).

Small Grain Varieties Released in 1975-76

<u>Name or Designation</u>	<u>Class or Type</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>WHEAT</u>			
Agate	Hard Red Winter	ARS-Nebraska AES	Resistance to stem rust, moderate resistance to soilborne and wheat streak mosaic viruses, moderate resistance to Hessian fly.
Barbee	Soft White Club	ARS-Washington AES	Resistance to stripe rust.
Beau	Soft Red Winter	ARS-Purdue AES	Ribeiro resistance to Hessian fly, stiff straw, general resistance to <u>Septoria tritici</u> .
Daws	Soft White Winter	ARS-Washington AES	Resistance to stripe rust and common bunt, short straw (semidwarf), more winterhardy than Gaines.
Downy	Soft Red Winter	ARS-Purdue AES	Resistance to cereal leaf beetle.
Key	Soft Red Winter	ARS-Purdue AES	High protein (for specific food processing markets only).
Kitt	Hard Red Spring	ARS-Minnesota AES	Equal in yield to Era but better milling and baking quality.
Lancota	Hard Red Winter	ARS-Nebraska AES	High protein, equal to Centurk in yield.
Lew	Hard Red Spring	ARS-Montana AES	Resistance to wheat stem sawfly.
Newana	Hard Red Spring	ARS-Montana AES	Short straw (semidwarf), resistance to stem rust and stripe rust.
Raeder	Soft White Winter	ARS-Idaho AES (developed at Wash. AES)	Short straw (semidwarf), resistance to stripe rust.
Urquie	Soft Winter Spring	ARS-Washington AES	Cold-hardy, short straw (semidwarf) mature-plant resistance to stripe rust.

Appendix 1

<u>Name or Designation</u>	<u>Class or Type</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>OATS</u>			
Allen	Spring	ARS-Purdue AES	Tolerance to barley yellow dwarf virus.
Lang	Spring	ARS-Illinois AES	High yield, resistance to barley yellow dwarf virus.
Otana	Spring	Montana AES (developed by ARS & Idaho AES)	High yield.
<u>BARLEY</u>			
Pike	6-row, winter	ARS-Purdue AES	Increased winterhardiness and early maturity.
<u>RICE</u>			
Calrose 76	short-grain	ARS-California AES	Short, stiff, straw (first short-stature rice released in California).
LA 110	medium-grain industrial	ARS-Louisiana AES	Industrial use, high yield.
M5	short-grain	ARS-California AES-California Co-Op Rice Research Foundation	Early maturity.
Nova 76	medium-grain	ARS-Arkansas AES	Early, better blast resistance and slightly shorter straw than Nova 66.

Small Grain Germplasm Released in 1975-76

<u>Name or Designation</u>	<u>Class or Type</u>	<u>Release Agencies</u>	<u>Reason for Release</u>
<u>WHEAT</u>			
Amigo	Hard Red Winter	ARS-Oklahoma AES	Resistance to Biotype C Greenbug (transferred from rye to wheat).
Centana genetically similar lines (11 in number)	Hard Red Spring	ARS-Montana AES	Height classes: 4 short lines (2 dwarfing genes); 3 semidwarf lines (1 dwarfing gene); and 4 standard lines (no dwarfing genes).
CI 17454 to CI 17461 (8 lines)	Hard Red Winter	ARS-Michigan AES	Resistance to cereal leaf beetle.
CI 17462 (bulk)	Hard Red Spring & Hard Red Winter	ARS-Michigan AES	Resistance to cereal leaf beetle.
Fuzz	Soft Red Winter	ARS-Purdue AES	Resistance to cereal leaf beetle.
Little Club x Agrus (4 lines)	Hard Red Spring	ARS-Oklahoma AES	Resistance to stem rust.
Little Club x Agent (4 lines)	Hard Red Spring	ARS-Oklahoma AES	Resistance to stem rust.
<u>OATS</u>			
MN 72106-124		ARS-Minnesota AES	Combined seedling and adult plant resistance to stem rust.
MN 711029B		ARS-Minnesota AES	Combined slow rusting from <u>Avena sterilis</u> and seedling resistance to stem rust.
<u>BARLEY</u>			
Composite Cross XXXIII-A		ARS-Arizona AES	Resistance to barley yellow dwarf virus, short, stiff straw, adapted to early planting in Arizona (early December).
Composite Cross XXXIII-B		ARS-Arizona AES	Resistance to barley yellow dwarf virus, rapid, early growth, short, stiff straw, adapted to late planting in Arizona (Feb.)

Selected Publications

Idaho

Pomeranz, Y., D. M. Wesenberg, R. T. Smith, G. S. Robbins, and J. T. Gilbertson. Amino acid composition of barley kernels from different parts of the spike. Cereal Chem. In press. (Acceptance January 12, 1976).

Wesenberg, D. M., R. M. Hayes, and H. C. McKay. Barley varieties for southern Idaho. University of Idaho Current Information Series No. 215 (Revised). 1976.

Iowa

Patanothai, Soontree, L. J. Michel, and M. D. Simons. 1975. Comparison of different hill-plot designs for evaluating qualitative response to oat crown rust. Crop. Sci. 15:803-806.

Texas

Bollich, C. N. and J. E. Scott. Past, present and future rice varieties. Chapter 5 IN Six Decades of Rice Research in Texas, Texas Agricultural Experiment Station Research Monograph No. 4. 1976. pp. 37-42.

Bollich, C. N., J. E. Scott, B. D. Webb, and J. G. Atkins. Registration of Brazos rice. Crop. Sci. 15:887. 1975.

Bollich, C. N., B. D. Webb, J. E. Scott, and J. G. Atkins. Registration of Lebonnet rice. Crop Sci. 15:886. 1975.

Webb, B. D. Evaluation of rice milling, cooking and processing qualities. Chapter 13 IN Six Decades of Rice Research in Texas, Texas Agricultural Experiment Station Research Monograph No. 4. 1976, pp. 97-106.

Maryland

Kilpatrick, R. A. 1975. New wheat cultivars and longevity of rust resistance, 1971-75. U.S. Dept. Agr., ARS-NE 64, 20 pp.

Montana

Confer, B., D. E. Mathre, and E. A. Hockett. 1975. Factors influencing the susceptibility of male-sterile barley to ergot. Crop Sci. 15:194-196.

Hockett, E. A., J. A. Benson, and R. F. Eslick. 1975. Registration of Purcell barley (Reg. No. 143). Crop Sci. 15:603.

Shaw, A. F., E. A. Hockett, and M. J. Jackosn. 1975. Malting barley production. Mont. State Univ. Bull. 1131:1-12.

Publications

South Dakota

Price, P. B. and J. G. Parsons. Lipids of seven cereal grains. J. Amer. Oil Chem. Soc. (1975):490-493.

Sears, E. R. A Triticum timopheevii chromosome homoeologous to T. aestivum chromosome 6B. Absts. XII Intl. Bot. Congr. 2:512. 1975.

Sears, E. R. An induced homoeologous-pairing mutant in Triticum aestivum. Genetics 80: s74. 1975.

Oregon

Hoffman, J. A., and R. J. Metzger. Current status of virulence genes and pathogenic races of the wheat bunt fungi in the Pacific Northwest. Phytopathology 66: (in press).

Trione, E. J. Free amino acid changes during germination of teliospores of the wheat bunt fungus Tilletia caries. American Journal of Botany, (Accepted Sept. 2., 1975).

California

Rutger, J. N., M. L. Peterson, C. H. Hu and W. F. Lehman. 1976. Induction of useful short stature and early maturing mutants in japonica rice (Oryza sativa L.) cultivars. Accepted for publication in Crop Science.

Davis, M. D. and J. N. Rutger, 1976. Yield of F₁, F₂, and F₃ hybrids of rice (Oryza sativa L.). Accepted for publication in Euphytica.

Michigan

Gullord, M., C. R. Olien, and E. H. Everson. Evaluation of Freezing Hardiness in Winter Wheat. Crop Sci. 15 (1975): 153-157.

Olien, C. R., and B. L. Marchetti. Recovery of Hardened Barley from Winter Injuries. Crop Sci. 16 (1976): 201-204.

North Dakota

Shuey, W. C. 1975. Practical instruments for rheological measurements on wheat products. Cereal Chem. 52(3), Part II: pp. 42r-81r.

Shuey, W. C., and Maneval, R. D. 1976. Changes in milling characteristics of new spring wheat varieties. Proceedings of 9th Nat'l. Conf. on Wheat Utilization Research, ARS-NC 40, pp. 86-94.

Shuey, W. C. 1976. Influence of wheat cultivars and environment on Agtron values and flour ash. Cereal Chem. 53:429-437.

Publications

Joppa, L. R., J. A. Bietz, and C. McDonald. 1975. Development and characteristics of a disomic-1D addition line of durum wheat. Can. J. Genet. Cytol. 17:355-363.

Quick, J. S., D. E. Walsh, K. L. Lebsock, and J. D. Miller. 1975. Registration of Rugby durum wheat. Crop Sci. 15:604. (Citation incomplete in FY 1975 WRU Report).

Quick, J. S., D. E. Walsh, K. L. Lebsock, and J. D. Miller. 1976. Registration of Botno durum wheat. Crop Sci. 16:124. (Citation incomplete in FY 1975 WRU Report).

Quick, J. S., D. E. Walsh, K. L. Lebsock, and J. D. Miller. 1976.. Registration of Crosby durum wheat. Crop Sci. 16:125. (Citation incomplete in FY 1975 WRU Report).

Long, D. L. and R. G. Timian. 1975. Some properties of oat blue dwarf virus. Phytopathology 65:848-851.

Timian, R. G. Barley stripe mosaic virus and the world collection of barleys. Plant Disease Reporter. 59:984-988. 1975.

Florida

Luke, H. H., R. D. Barnett, and W. H. Chapman. Types of horizontal resistance to crown rust. Plant Dis. Reptr. 59:332-334. 1975.

Luke, H. H., R. D. Barnett, and P. L. Pfahler. Inheritance of horizontal resistance to crown rust in oats. Phytopathology 65:631-632. 1975.

Barnett, R. D. and H. H. Luke. The effects of fungicides on disease development, seed contamination, and grain yield of wheat. Plant Dis. Reptr. 50: 117-119. 1976.

Nebraska

Ulmer, R. L., P. J. Mattern, V. A. Johnson, and C. Kies. Protein nutritional value of wheat and triticale as evaluated by weanling mice bioassay. Crop Sci. 15:(1975) 522-524.

Vogel, K. P., V. A. Johnson, and P. J. Mattern. Reevaluation of common wheats from the USDA World Wheat Collection for protein and lysine content. Res. Bul. 272: (1975) 36 pages.

Johnson, V. A., P. J. Mattern, J. E. Stroikey, and K. D. Wilhelmi. Breeding for improved nutritional quality in wheat. Proc. 2nd Int. Winter Wheat Conf., Zagreb, Yugoslavia. Misc. Publ. 32:(1975) 316-333.

Publications

Nebraska

Johnson, V. A. Opportunity to improve the nutritional value of wheat through breeding. Proc. Ninth Natl. Conf. on Wheat Utilization Research. ARS-NC-40: (1976) 54-60.

Palmer, L. T. and M. K. Brakke. Yield reduction in winter wheat infected with soilborne wheat mosaic virus. Plant Disease Reporter 59:(1975) 469-471.

Utah

Hoffmann, J. A. and R. J. Metzger. 1976. Current status of virulence genes and pathogenic races of the wheat bunt fungi in the Northwestern USA. Phytopathology 66: In press.

Wisconsin

Ohm, H. W. and David M. Peterson. Protein composition in developing groats of an Avena sativa L. cultivar and an A. sativa X Avena sterilis L. selection. Crop Sci. 15: 855-858 (1975).

Peterson, David M. and Dale Smith. Changes in nitrogen and carbohydrate fractions in developing oat groats. Crop Sci. 16:67-71 (1976).

Oplinger, E. S., W. A. Veith, and V. L. Youngs. Oat agronomic and grain quality responses to growth regulators. Agronomy J. 67:443-45 (1975).

Youngs, V. L. and Jerome Senturia. The relationship in protein concentration between whole oats and oat groats. Crop Sci. 16:87-88 (1976).

Briggle, L. W., R. T. Smith, Y. Pomeranz and G. S. Robbins. Protein concentration and amino acid composition of Avena sterilis L. 1975. Crop Sci. 15:547-549.

Burger, W. C. and R. L. Schroeder. A sensitive method for detecting endopeptidases in electrofocused thin-layer gels. 1976. Anal. Biochem. 71:384-392.

Prentice, N. Invertase as a measure of malting quality of barley. 1975. Cereal Chem. 52:650-655.

Wesenberg, D. M., R. M. Hayes, N. N. Standridge, W. C. Burger, E. D. Goplin and F. C. Petr. Registration of Karl barley. Crop Sci. 16:737 (1976).

Kansas

Livers, R. W. and K. F. Finney. Registration of 'Eagle' wheat. Crop Sci. 15(5):737. 1975.

Finney, K. F. A sugar-free formula for regular and high-protein breads. Baker's Digest 49(6): 18-22. 1975.

Publications

Finney, P. L., C. D. Magoffin, R. C. Hoseney, and K. F. Finney. Short-time baking systems. I. Interdependence of yeast concentration, fermentation time, proof time, and oxidation requirement. Cereal Chem. 53(1): 126-134. 1976.

Pomeranz, Y., M. D. Shogren, L. C. Bolte, and K. F. Finney. Functional properties of dark hard and yellow hard red winter wheat. Baker's Digest 50 (1):35-40. 1976.

Finney, K. F., Y. Pomeranz, and R. C. Hoseney. Effects of solvent extraction on lipid composition, mixing time, and bread loaf volume. Cereal Chem. 53(3): 383-388. 1976.

Pomeranz, Y., M. D. Shogren, K. F. Finney, and D. B. Bechtel. Fiber in breadmaking - effects on functional properties. Cereal Chem., In press.

Browder, L. E. and H. C. Young, Jr. Further development of an infection-type coding system for the cereal rusts. Plant Disease Reporter 59:964-965. 1975.

Browder, L. E. and M. G. Eversmeyer. Recording and Machine processing of cereal rust infection-type data. Plant Disease Reporter 60:143-147. 1976.

Eversmeyer, M. G., C. L. King, and W. G. Willis. Control of leaf and stem rust of wheat by aerial application of a zinc and Meheb fungicide in Kansas in 1974. Plant Disease Reporter 59: 607-609. 1975.

Washington

Allan, R. E. 1975. The relation of flag smut incidence to semidwarf growth habit in wheat isolines. Crop Sci. 15:427-429.

Allan, R. E. and J. A. Pritchett. 1975. Registration of 20 lines of wheat germplasm. Crop Sci. 15:891-892.

Cook, R. J. and A. A. Christen. 1976. Growth of cereal root-rot fungi as affected by temperature - water potential interactions. Phytopathology 66:193-197.

Finney, P. L., C. D. Magoffin, R. C. Hoseney, and K. F. Finney. 1976. Short-time baking systems I. Interdependence of yeast concentration, fermentation time, proof time, and oxidation requirement. Cereal Chem. 53:126.

Sollars, W. F. and G. L. Rubenthaler. 1975. Flour fractions affecting Farinograph absorption. Cereal Chem. 52:420-427.

Publications

Minnesota

Heiner, Robert E., D. V. McVey, and F. A. Elsayed. 1976. Registration of Kitt wheat. Crop Sci. (In press).

Kapoor, Amin C. and Robert E. Heiner. 1976. Biochemical changes in developing wheat grains. Changes in proteins, carbohydrates, and nucleic acids. Can. J. Plant Sci. (In press).

Pepe, John F., and Robert E. Heiner. 1975. Plant height, protein percentage, and yield relationships in spring wheat. Crop Sci. 15:793-797.

Schmidt, J. W. , V. A. Johnson, P. J. Mattern, A. F. Dreier, and D. V. McVey. Registration of HiPlains wheat. Registration of Homestead wheat. Registration of Sentinel wheat. (3 articles). Crop Science: In press. (Accepted for publication 5/24/76).

Schmidt, J. W., V. A. Johnson, P. J. Mattern, A. F. Dreier, D. V. McVey, and H. W. Somsen. Registration of Buckskin wheat. Crop Science: In Press. (Accepted for publication 5/24/76).

Arkansas

Faw, Wade F. and T. H. Johnston. 1975. Effect of seeding date on growth and performance of rice varieties in Arkansas. Arkansas Agr. Exp. Sta. Rept. Series 224. 30 pp.

Pennsylvania

Marshall, H. G. 1976. Genetic changes in oat bulk populations under winter survival stress. Crop Science 16:9-15.

Pomeranz, Y., Marshall, H. G., Robbins, G. S., and J. T. Gilbertson. 1975. Protein content and amino acid composition of maturing buckwheat (Fagopyrum esculentum Moench). Cereal Chemistry 52:479-485.

Illinois

Thongmeearkom, P., R. E. Ford, and H. Jedlinski. Aphid transmission of maize dwarf mosaic virus strains. Phytopathology 66:332-335. 1976.

Ohio

Kissell, L. T. and W. T. Yamazaki. Protein enrichment of cookie flours with wheat gluten and soy flour derivatives. Cereal Chem. 52:638 (1975).

Kissell, L. T. and K. Lorenz. Performance of triticale flours in tests for soft wheat quality. Cereal Chem. 53:233 (1976).

NRP Annual Report
FY 1976

NRP 20060 Breeding and Production--Cotton

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Cotton fiber, and food and feed from cottonseed, are vital resources for the USA. The mission of this National Research Program is to develop new knowledge which will increase the production efficiency of this basic crop. This mission is being accomplished through two Technological Objectives:

Technological Objective I

New and improved genetic populations, breeding lines, and varieties of cotton that combine increased yield potentials and favored quality characteristics of seed and lint with increased resistance to pests, tolerance to environmental stresses, and adaptation to modern cultural, harvesting, and handling practices.

Selected Examples of Progress:

Verticillium wilt tolerant variety of cotton released for the San Joaquin Valley of California. Acala SJ-4 was released for commercial production on soils which are moderately to severely infected with Verticillium wilt. On these soils the new variety out yielded the older SJ-2 variety by 23%. Fiber from SJ-4 produces stronger yarns in the mills. The new cultivar also has superior seed quality with lower seed fuzz, lower gossypol, and higher oil and nitrogen contents. (Shafter, CA, Davis, CA, and Knoxville, TN, in cooperation with the California Agricultural Experiment Station)

New extra-long-staple cotton variety released. A new, higher yielding and earlier maturing variety of Pima cotton has been released for commercial production. This variety, designated as Pima S-5, outyielded the older Pima S-4 variety by 18 to 35 percent in a series of tests on producer's farms in Arizona, New Mexico, and the El Paso area of Texas. Pima S-5 is particularly well adapted at the lower elevations and appears to have greater heat tolerance during the fruiting period. The premium fiber quality of the Pima cottons has been maintained in this newest release. (Phoenix, AZ, El Paso, TX, and Knoxville, TN, in cooperation with the Arizona State Agricultural Experiment Station).

Plant Breeding to Reduce Dependence on Insecticides in Cotton. Eight experimental (noncommercial) strains of cotton were released with special morphological and biochemical properties which suppress bollworm, pink bollworm, fleahopper, and plant bug populations by 40 to 60 percent. Cotton strains lacking normal nectaries (which attract and nourish certain insects)

appear especially promising. This germplasm in combination with integrated management practices offers the potential for substantially reducing the amounts of insecticide needed to produce cotton. Public and private breeders are utilizing these germplasm sources for developing new commercial cotton varieties. (Brownsville, TX, and Stoneville, MS, in cooperation with the respective SAES).

Superior fiber properties combined with high yields in cotton germplasm releases. Ten divergent experimental (noncommercial) breeding lines with unique and desirable combinations of superior fiber quality and high lint yields were released and distributed to private and public cotton breeders in 1974 and 1975. These releases represent over 30 years of genetic and breeding research effort. This material has a broad germplasm base contributed by numerous widely diverse ancestors and is also a valuable new source of insect and disease resistance. (Florence, SC, and Knoxville, TN)

Cotton germplasm collections expanded and studied. Fifty-one seed accessions of G. arboreum and G. herbaceum were received from the Vavilov Institute in Leningrad and are being increased and studied. Miscellaneous new accessions continue to be received from various parts of the world. A nomenclatural analysis of Gossypium has been completed (Fryxell, Paul A., A Nomenclator of Gossypium - The Botanical Names of Cotton. Technical Bulletin No. 1491, 114 pp. Agricultural Research Service, USDA, in cooperation with the Texas Agricultural Experiment Station and Texas A&M University. March 1976). The collection, maintenance, and study of cotton germplasm is essential to provide the genetic resources needed to reduce further risk of widespread losses to weather, insects, and diseases. (College Station, TX, and Phoenix, AZ, and cooperative work with the Mississippi SAES).

Conversion of photoperiodic race collections to day-neutral types. The majority of the G. hirsutum races collected from Mexico and Central America do not produce mature cottonseed when grown in the field in the U.S. Cotton Belt. Consequently, a cooperative effort between ARS at Mississippi State, ARS at Lubbock, TX, and the Agronomy Department at Mississippi State University has been initiated to convert this race collection to day-neutral types which will flower and produce seed in the United States. The Winter Nursery Facilities at Iguala, Mexico, provide a very suitable location for making the initial crosses and growing materials which do not flower in the Cotton Belt. This race collection has proved to be a very valuable source of genetic resistance or tolerance to plant pests and environmental stresses. Conversion to types which will flower in the USA will greatly simplify and enhance the use of this valuable genetic material by all public and private plant breeders. (Mississippi State, MS, and Lubbock, TX, in cooperation with Mississippi State University).

Search for host plant resistance to insects emphasized. Germplasm is being screened for resistance to insects in all of the major cotton producing areas. Nectariless cotton reduced lygus bugs by 50-75% in California.

Twenty-five strains of Upland cotton and eight strains of Pima cotton were identified as having resistance to pink bollworms and leafperforators in Arizona. Glabrous, nectariless and high bud-gossypol cottons have been shown to significantly reduce populations of fleahoppers, bollworms and budworms in Texas. At least five insecticidal terpenoids which are toxic to bollworms and budworms have been isolated from cotton squares and leaves and are being characterized chemically. Genetic sources of resistance to boll weevils, the bollworm complex, lygus, whiteflies, and spider mites have been identified in Mississippi. The genetics of two important resistance traits, terpenoid levels and leaf smoothness, are being investigated in North Carolina. (Shafter, CA, Phoenix, AZ, Brownsville, TX, College Station, TX, Stoneville, MS, Mississippi State, MS, and Raleigh, NC).

Increasing host plant resistance to root knot nematodes and fusarium wilt. Genetic sources of resistance to this disease complex have been identified which are greatly superior to the level of tolerance exhibited by current commercial varieties. A recent germplasm (noncommercial) release from ARS at Auburn, AL, and Alabama Agricultural Experiment Station, designated as Auburn 623 RNR, is particularly outstanding in level of resistance but is noncompetitive in lint yield. Additional sources of excellent resistance have also been identified in other noncommercial materials. The transfer of this superior resistance into higher yielding adapted breeding lines is in progress. This disease complex is encountered in various areas throughout the entire Cotton Belt and causes an estimated \$20 million loss in yields annually. (Auburn, AL, Lubbock, TX, and Shafter, CA).

Possibility of breeding for improved water use efficiency in cotton. Stomatal behavior as an indication of physiological adaptation to drought appears to be under genetic control in cotton. Although the research is preliminary at this time, it suggests that it may be possible to breed new cultivars with better adaptation to the semiarid environment of the Southern Great Plains. (Lubbock, TX).

Fiber quality improvement. The Cotton Quality Laboratories at Knoxville, TN, are the center for ARS research directed towards altering the quality of the fiber for continued improvement in processing efficiency and consumer acceptance. Approximately 10,000 fiber samples from the 1974 and 1975 crops were evaluated for length, strength, and fineness, and 7,100 samples from the 1975 season were spun into yarns for quality evaluation. Data are supplied to the cooperating researchers investigating the improvement of germplasm and cultural practices. Stress-strain properties of cotton fibers and their response to chemical modifications also are being investigated in the laboratories. Relationships among yield and quality components with partitioning of genetic and environmental effects are being studied. Basic research is in progress concerning the physiological and biochemical processes involved in seed and fiber development. (Knoxville, TN).

Technological Objective II

New and improved cultural and management practices that optimize yield potentials, minimize production losses, preserve quality attributes, and conserve and utilize resources efficiently.

Selected Examples of Progress:

Note - Some of the material presented under Technological Objective I could also be appropriately presented under this objective. For more detailed information, reference also should be made to the related NRP's, particularly 20170 (Physiology and Biochemistry), 20230 (Cotton and Tobacco Insect Control), 20270 (Diseases and Nematode Control), and 20290 (Agricultural Chemical Technology).

Plant growth regulators for insect control. New chemicals applied to cotton for terminating late season fruiting greatly reduces pink bollworm populations. This practice, particularly when used in conjunction with nectariless varieties and judicious use of insecticides, could substantially reduce the quantity and cost of chemical insecticides and increase the efficiency of cotton harvesting. (Phoenix, AZ)

Anti-transpirant leaf sprays effective in reducing chilling injury to cotton seedlings. Controlled environment experiments show dehydration as the major consequence of chilling to emerged cotton seedlings. Cotton seedling roots are incapable of water uptake below 10-12°C (50-54°F) and cotyledons suffer water deficit. Maintenance of high humidity around chilled cotton seedlings prevents chilling injury or stand loss. Anti-transpirant materials and combinations of these materials with ascorbic acid are sprayed on the seedling plants. These materials close the plant stomates, preventing water loss, and are thus effective in preventing stand loss during periods of low temperature following planting. (Beltsville, MD).

Successful tissue culture induction and maintenance techniques developed for cotton. A procedure was developed in which sizeable quantities of callus tissue are produced from cotton anthers. Optimal levels of nitrogen, sucrose, auxin, cytokinin and bud size were established for inducing the initial callus. Reliable procedures for maintaining callus tissue were developed by altering sugar source and adding ascorbic acid. Research also is in progress on culturing cotton ovules and inducing and maintaining callus from this source. Experiments for regenerating plants from callus tissue are now in progress. If successful, this technique would be an invaluable tool in breeding, genetic, mutation, screening and physiological research. (Las Cruces, NM, and Knoxville, TN).

Basic research in the physiology and biochemistry of the cotton plant.

The possibility of increasing the photosynthetic efficiency of the cotton plant is being investigated. The effects of temperature, moisture, and CO₂ concentrations are being characterized. Starch metabolism, storage, and breakdown have been shown to be an important factor interacting with rate of photosynthesis. Controls on nitrate assimilation and their relationship to photosynthesis also are under study. Ammino acid composition of developing cottonseed has been determined. Nitrogen fertilizer, temperature, water status, and developmental growth period have all been shown to be important factors affecting cottonseed composition. Protein synthesis has been shown to be important in the chilling tolerance of germinating seedlings. Modes of action of defoliant and growth retardation are being examined. Research on the biochemical and physiological basis of disease infection and resistance are providing a basis for developing more efficient methods of control. Journal publications document the specific progress and advances being made in these areas. (Phoenix, AZ, College Station, TX, and Stoneville, MS).

Selected Publications

NRP 20060 - FY 1976

Generally, only publications in refereed journals or bulletins have been listed. Abstracts, publications in proceedings of meetings and workshops, and articles in the popular press have not been included. Much of this latter information has been or will be published in more complete form in the scientific journals. It should be noted that a great deal of information on the progress of cotton production research is available in the following proceedings:

Proceedings of the 1976 Beltwide Cotton Production Research Conference

Proceedings of the 1976 Beltwide Cotton Production - Mechanization Conference

Proceedings Western Cotton Production Conference, February 1976

Beltsville, MD

Ambler, J. E., D. T. Krizek, and P. Semeniuk. 1975. Influence of UV-B radiation on early seedling growth and translocation of ^{65}Zn from cotyledons of cotton. *Physiol. Plant.* 34:177-81.

Cole, D. F., and M. N. Christiansen. 1975. Effect of chilling duration on germination of cottonseed crop. *Sci.* 15:410-12.

Shafter, CA

None

Davis, CA

Schnathorst, W. C., T. A. Reeve, and Diana Fogle. 1975. *Verticillium dahliae* strains in cotton plants in the Pahrump Valley, Nevada. *Plant Disease Repr.* 59:863-65.

Schnathorst, W. C., and H. B. Cooper, Jr. 1976. Evaluation of Russian Cotton cultivars for *Verticillium* wilt tolerance. *Plant Disease Repr.* 60:211-14.

Las Cruces, NM

Barrow, J. R., and M. P. Dunford. 1975. Somatic crossing over as a cause of intergenome translocations in haploid cotton. *J. of Hered.* 66:277-80.

Chaudhari, H. K., and J. R. Barrow. 1975. Identification of cotton haploids by stomatal chloroplast count techniques. *Crop Sci.* 15: 760-63.

Phoenix, AZ (Breeding and Genetics)

- Smith, R. L., R. L. Wilson, and F. D. Wilson. 1975. Resistance of cotton plant hairs to mobility of first-instars of the pink bollworm. J. Econ. Entomol. 68:679-83.
- Turcotte, E. L., and C. V. Feaster. 1975. Effect of R₁, a gene for red plant color on American Pima cotton. Crop Sci. 15:875-76.
- Wilson, R. L., and F. D. Wilson. 1975. Comparison of an x-ray and a green-boll technique for screening cotton for resistance to the pink bollworm. J. Econ. Entomol. 68:636-38.
- Wilson, R. L., and F. D. Wilson. 1975. A laboratory evaluation of primitive cotton races for pink bollworm resistance. ARS-W-30.
- Wilson, R. L., and F. D. Wilson. 1975. Effects of pilose, pubescent, and smooth cottons on the cotton leafperforator. Crop Sci. 15: 807-09.
- Wilson, F. D., and R. L. Wilson. 1975. Breeding potentials for non-cultivated cottons. I. Some agronomic and fiber properties of selected parents and F₁. Crop Sci. 15:763-66.

Phoenix, AZ (Plant Physiology)

- Butler, G. D., D. L. Kittock, and L. L. H. Pinkas. Growth and fruiting of two Pima cottons. Bull. ARS W-28:24.
- Guinn, G. 1976. Nutritional stress and ethylene evolution by young cotton (*Gossypium hirsutum* L.) bolls. Crop Sci. 16:89-91.
- Guinn, G. 1976. Water deficit and ethylene evolution by young cotton bolls. Plant Physiol. 57:403-05.
- Kittock, D. L. 1975. Skip-row planting of Pima cotton. Agron. J. 67: 712-14.
- Kittock, D. L., L. A. Bariola, H. Fred Arle, and P. V. Vail. 1975. Evaluation of chemical termination of fruiting for pink bollworm control by estimating number of immature cotton bolls at harvest. Cotton Grow. Rev. 52:224-27.
- Kittock, D. L., and Leonard L. H. Pinkas. 1975. Relationship of seed per boll to other yield components and fiber quality of Pima cotton. Crop Sci. 15:316-19.
- Radin, J. W., and C. R. Sell. 1975. Growth of cotton plants on nitrate and ammonium nitrogen. Crop Sci. 707-10.
- Radin, J. W., and C. R. Sell. 1975. Some factors limiting nitrate reduction in developing ovules of cotton. Crop Sci. 15:713-15.
- Radin, J. W., C. R. Sell, and W. R. Jordan. 1975. Physiological significance of the in vivo assay for nitrate reductase in cotton seedlings. Crop Sci. 15:710-13.

Brownsville, TX

- Dilday, R. H., R. J. Kohel, and T. R. Richmond. 1975. Genetic analysis of leaf differentiation mutants in upland cotton. Crop Sci. 15:393-7.

- Dilday, R. H., and T. N. Shaver. 1976. Survey of the regional Gossypium hirsutum L. primitive race collection for flowerbud gossypol. USDA, ARS-S-80, p. 1-7.
- Gray, J. R., T. J. Mabry, A. A. Bell, R. D. Stipanovic, and M. J. Lukefahr. 1976. para-Hemigossypolone: A sesquiterpenoid aldehyde quinone from Gossypium hirsutum. J. Chem. Soc. D Chem. Commun., pp. 109-10.
- Lukefahr, M. J., J. E. Houghtaling, and D. G. Cruhm. 1975. Suppression of Heliothis spp. with cottons containing combinations of resistant characters. J. Econ. Entomol. 68:743-6.

College Station, TX (Nat'l Path. Res. Lab.)

- Baur, J. R., R. W. Bovey, and J. A. Veech. 1976. Growth responses in sorghum and wheat induced by glyphosate. J. Exp. Bot. Accepted for publication 5/11/76.
- Beckman, C. H., G. E. VanderMolen, W. C. Mueller, and M. E. Mace. 1976. Vascular structure and distribution of vascular pathogens in cotton. Physiol. Plant Pathol. Accepted for publication 3/15/76.
- Bell, A. A., J. E. Puhalla, W. J. Tolmsoff, and R. D. Stipanovic. 1976. Use of mutants to establish (+)-scytalone as an intermediate in melanin biosynthesis by Verticillium dahliae. Can. J. Microbiol. 22. Accepted for publication 2/20/76.
- Bell, A. A., R. D. Stipanovic, and J. E. Puhalla. 1976. Pentaketide metabolites of Verticillium dahliae. Identification of (+)-scytalone as a natural precursor to melanin. Tetrahedron. Accepted for publication 1/16/76.
- Bell, A. A., R. D. Stipanovic, J. E. Puhall, M. H. Wheeler, and W. J. Tolmsoff. 1976. Pentaketide pathway of melanin biosynthesis in Verticillium dahliae. Proc. 2nd Intern. Symp. on Verticillium. Accepted for publication 5/14/76.
- Gray, J. R., T. J. Mabry, A. A. Bell, R. D. Stipanovic, and M. J. Lukefahr. 1976. para-Hemigossypolone: A sesquiterpenoid aldehyde quinone from Gossypium hirsutum. J. Chem. Soc., Chem. Comm.:109-10.
- Halloin, J. M. 1975. Postharvest infection of cottonseed by Rhizopus arrhizus, Aspergillus niger, and Aspergillus flavus. Phytopathology 65:1229-32.
- Halloin, J. M. 1976. Inhibition of cottonseed germination with abscisic acid and its reversal. Plant Physiology 57:454-55.
- Howell, C. R., A. A. Bell, and R. D. Stipanovic. 1976. Effect of aging on flavonoid content and resistance of cotton leaves to verticillium wilt. Physiol. Plant Pathol. 8:141-88.
- Mace, M. E. 1976. Anatomical and histochemical responses to Verticillium infection in Verticillium-resistant and -susceptible cottons. Proc. 2nd Intern. Symp. on Verticillium. Accepted for publication 5/14/76.
- Mace, M. E., A. A. Bell, and C. H. Beckman. 1976. Histochemistry and identification of disease-induced terpenoid aldehydes in Verticillium wilt-resistant and -susceptible cottons. Can. J. Botany. Accepted for publication 4/1/76.

- Puhalla, J. E., and C. R. Howell. 1975. Significance of endopolygalacturonase activity to symptom expression of Verticillium wilt in cotton, assessed by the use of mutants of Verticillium dahliae Kleb. Physiological Plant Pathology 7:147-52
- Puhalla, J. E. Glycerol as a selective agent for auxotrophs of Verticillium dahliae. J. Gen. Microbiology. Accepted for publication 2/25/76.
- Puhalla, J. E., and W. W. Carter. 1976. The role of the Hlocus in heterokaryosis in Rhizoctonia solani. Phytopathology 66. Accepted for publication 5/18/76.
- Stipanovic, R. D., and A. A. Bell. 1976. Pentaketide metabolites of Verticillium dahliae. 3. Identification of (-)-3,4-dihydro-3,8-dihydroxy-1(2H)naphtalenone [(-)-vermelonel] as a precursor to melanin. J. Org. Chem. Accepted for publication 4/9/76.
- Stipanovic, R. D., and H. W. Schroeder. 1976. Zearalenol and 8'-hydroxy-zearalenone from Fusarium roseum. Mycopathologia 57:77-78.
- Stipanovic, R. D., and H. W. Schroeder. 1976. Preechinulin, a metabolite of Aspergillus chevalieri. Trans. Br. Mycol. Soc. 66:178-79.
- Stipanovic, R. D., H. W. Schroeder, and H. Hein, Jr. 1976. Identification of D-valyl-L-tryptophan anhydride from Aspergillus chevalieri. Lloydia. Accepted for publication 11/24/75.
- Veech, J. A., and R. E. Hunter. 1976. Peroxidase activity in cotton hypocotyls infected by Rhizoctonia solani: A spectrophotometric study. Proc. Beltwide Cotton Prod. Res. Con.:26. Abstract.
- Veech, J. A., R. D. Stipanovic, and A. A. Bell. 1976. Peroxidative conversion of hemigossypol to gossypol. A revised structure for isohemigossypol. J. Chem. Soc., Chem. Comm.:144-45.
- Wakelyn, P. J., G. A. Greenblatt, D. F. Brown, and V. W. Tripp. 1976. Chemical properties of cotton dust. Amer. Industrial Hygiene Assoc. J. 37:22-31.
- Wheeler, M. H., W. J. Tolmsoff, and S. M. Meola. 1976. Ultra-structure of melanin formation in Verticillium dahliae with (+)-scytalone as a biosynthetic intermediate. Can. J. Microbiol. 22:702-11.

College Station, TX (Cotton Genetics Research)

- Bell, Alois A., R. D. Stipanovic, C. R. Howell, and P. A. Fryxell. 1975. Antimicrobial terpenoids of Gossypium: Hemigossypol, 6-methoxyhemigossypol and 6-deoxyhemigossypol. Phytochem. 14:225-31.
- Benedict, C. R., and R. J. Kohel. 1975. Export of ¹⁴C-Assimilates in Cotton Leaves. Crop Sci. 15:367-372.
- Cross, W. H., M. J. Lukefahr, P. A. Fryxell, and H. R. Burke. 1975. Host plants of the boll weevil. Environm. Entomol. 4:19-26.
- Dilday, R. H., R. J. Kohel, and T. R. Richmond. 1975. Genetic Analysis of Leaf Differentiation Mutants in Upland Cotton. Crop Sci. 15:393-397.

- Fryxell, Paul A. 1975. Germplasm utilization: Gossypium, a case history. Abstr. XII Internatl. Bot. Congr., Leningrad 2:506. (Invitational).
- Fryxell, Paul A. 1976. A nomenclator of Gossypium--The botanical names of cotton. Technical Bulletin No. 1491:114 pp. ARS, U.S. Dept. of Agri. in cooperation with Texas Agricultural Experiment Station.
- Fryxell, Paul A. 1975. The taxonomy of Gossypium and the evolution of domesticated cottons. Abstr. XII Internatl. Bot. Congr., Leningrad 2:506. (Invitational).
- Fryxell, Paul A. 1975. The systematic placement of Decaschistia Wight & Arnott (Malvaceae) and the description of a new tribe, Decaschistieae. Amer. J. Bot. 62:172-175.
- Fryxell, Paul A. 1975. Sidus Sidarum. Sida 6:1-6.
- Kohel, R. J. 1974. Influence of certain morphological characters on yield. Cotton Grow. Rev. 51:281-292.

El Paso, TX

- Taylor, R. M., E. F. Young, Jr., and R. L. Rivera. 1975. Salt tolerance in cultivars of grain sorghum. Crop Sci. 15:734-735.

Lubbock, TX

- Minton, E. B. 1976. Cotton seed treatments. Crops and Soils 28(4): 10-11.
- Minton, E. B., and G. A. Fest. 1975. Seedling survival from cotton-seed treatment experiments at several locations. Crop Sci. 15:509-513.
- Quisenberry, J. E., and R. J. Kohel. 1975. Growth and development of fiber and seed in upland cotton. Crop Sci. 15:463-467.
- Quisenberry, J. E., L. L. Ray, and D. R. Rummel. 1975. Persistence of the glandless genotype in a composite cross of upland cotton on the Texas High Plains. Crop Sci. 15:883-884.

Stoneville, MS

- Hanny, B. W., and R. C. Guelldner. 1976. An investigation of the surface lipids of the glabrous cotton (Gossypium hirsutum L.) strain, Bayous SM1. J. Ag. Food Chem. 24:501.
- Leffler, H. R. 1976. Altered development of ribonuclease activity and formation of polyribosomes in chilled cotton cotyledons. Crop Sci. 16:71-75.
- McMichael, B. L., C. D. Elmore, and G. W. Cathey. 1976. Non-destructive method for the determination of boll surface area in cotton. Agronomy J. 68:426-427.
- Meredith, W. R., Jr., H. H. Ramey, Jr., and R. R. Bridge. 1975. Determination of yield, yield components and fiber properties as influenced by selective and nonselective samplings. Crop Sci. 15: 432-435.

- Wergin, W. P., C. D. Elsmore, B. W. Hanny, and B. F. Ingber. 1975. Ultrastructure of the subglandular cells from the foliar nectariless of cotton in relation to the distribution of Plasmodesmata and the symplastic transport of nectar. *Am. J. Bot.* 62:842-849.

Mississippi State, MS

- Baker, Donald N., Johnnie N. Jenkins, and Jerry R. Lambert. 1975. An analysis of the impact of temperature and rainfall changes on growth and yield of Delta cottons. CIAP Monograph, Part 2, DOT 2, Chapter 4 pages 148-164. (Invitational chapter).
- Jenkins, Johnnie N., W. L. Parrott, and James W. Jones. 1975. Boll weevil behavior: Multiple punctured squares. *Environ. Entomol.* 4(6):861-867. (Forum Section).
- Jenkins, Johnnie N. 1976. Boll weevil resistant cotton varieties in boll weevil suppression, management, and elimination technology. ARS-S-71:45-50.
- Maxwell, F. G., P. A. Hedin, and Johnnie N. Jenkins. 1976. Host plant resistance to insects: Chemical relationships. April 10-15 International Conference on Controlling Insect Behavior: Theory and Application. Presented at Bellagio, Italy. (Invitational paper published in Proceedings of Conference).

Auburn, AL

- Kappelman, A. J., Jr. 1975. Fusarium wilt resistance in cotton (*Gossypium hirsutum*). *Plant Dis. Rptr.* 59:803-805.
- Kappelman, A. J., Jr. 1975. Correlation of fusarium wilt of cotton in the field and greenhouse. *Crop Sci.* 15:270-272.

Florence, SC

- Culp, T. W., and D. C. Harrell. 1975. Influence of lint percentage, boll size, and seed size on lint yield of Upland cotton with high fiber strength. *Crop Sci.* 15:741-746.
- Harrell, D. C., and T. W. Culp. 1976. Effects of yield components on lint yield of Upland cotton with high fiber strength. *Crop Sci.* 16:205-208.
- Worley, Smith, Jr., Harmon H. Ramey, Jr., D. C. Harrell, and T. W. Culp. 1976. Ontogenetic model of cotton yield. *Crop Sci.* 16:30-34.

Raleigh, NC

- Brown, W. G., Jr., and J. A. Lee. 1976. The effects of emasculation on seed set in three lines of *Gossypium*. *Crop Sci.* (in press).
- Lee, Joshua A. 1976. Transfer of a smoothleaf allele from *Gossypium hirsutum* L. *Crop Sci.* (in press).

Knoxville, TN

- Duckett, K. E., C. C. Cheng, and R. S. Krowicki. 1975. Application of weak-link theory to the determination of a true zero-gage tensile-test length of single cotton fibers. Text. Res. J. 45:817-818.
- Duckett, K. E., R. S. Krowicki, and C. C. Cheng. 1975. Some observations on single-fiber and flat-bundle tensile tests, and on the application of weak-link theory to the determination of a true zero-gage tensile-test length of single cotton fibers. Applied Polymer J. 27:359-368.
- Ewald, P. R., H. Hutchens, E. E. Norman, A. M. Sands, G. Wester, and P. W. Elliott. 1975. An opener-picker for a miniature spinning test. Textile Res. J. 45:401-403.
- Ewald, P. R., and R. Lawson. 1975. Yarn-strength index of cotton blended with synthetics in the 50-gram spinning test. Textile Res. J. 45:468-473.
- Ewald, Philip R. 1975. The 50-gram cotton spinning test: A tool for rapid staple fiber research. Applied Polymer J. No. 27:345-358.
- Hsu, Cecilia Lee, and James McD. Stewart. 1976. Callus induction by (2-chloroethyl) phosphonic acid on cultured cotton ovules. Physiol. Plant 36:150-153.
- Lawson, R., P. R. Ewald, and H. H. Ramey, Jr. 1975. Repeated yarn tenacity determinations of a lot of cotton. Text. Res. J. 45:698.
- Lawson, R. 1975. Response. Text. Res. J. 45:814-815.
- Lawson, Reba. 1975. Fiber and yarn data on sixty-two research cotton samples. USDA, ARS-S-55.
- Lawson, R., H. H. Ramey, Jr., and P. W. Elliott. 1975. Stress-strain properties of mercerized, stretched and durable-press treated cotton fibers. Textile Res. J. 45:510-514.
- Meredith, W. R., Jr., H. H. Ramey, Jr., and R. R. Bridge. 1975. Determination of yield, yield components and fiber properties as influenced by selective and nonselective samplings. Crop Sci. 15: 432-435.
- Ramey, H. H., Jr., J. H. Turner, Jr., and S. Worley, Jr. 1975. 1972 Regional Cotton Variety Tests. ARS-S-62.
- Stewart, J. M. 1975. Fiber initiation on the cotton ovule (Gossypium hirsutum L.). American J. Bot. 62(7):723-730.
- Stewart, J. McD., and E. N. Duncan. 1976. Cottonseed viability after longtime storage. Agron. J. 68:243-244.
- Turner, J. H., Jr., and D. Ferguson. 1975. Performance of cotton (Gossypium hirsutum L.) lines selected for high productivity in three environments. Theo. & Appl. Genetics 45:327-330.
- Worley, S., Jr., R. S. Krowicki, and Edwin L. Cox. 1975. Conversion of Micronaire reading to Arealometer specific-surface-area values in cotton. Textile Res. J. 45:326-327.
- Worley, Smith, Jr., H. H. Ramey, Jr., D. C. Harrell, and T. W. Culp. 1976. Ontogenetic model of cotton yield. Crop Sci. 16:30-34.

NRP Annual Report
FY 1976

NRP 20070 Breeding and Production--Tobacco

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Within this ARS National Research Program, emphasis is given to breeding, production, and curing techniques to enhance quality components of tobacco leaf and to reduce labor inputs. With the advent of the health issue in 1964, quality improvement research was expanded to include the reduction or removal from leaf or smoke of any constituents that may be identified as harmful. The high labor requirements for production and marketing of tobacco, coupled with a growing shortage of labor for these purposes, has resulted in an increasing economic strain on tobacco producers. The health issue and the high cost of tobacco as a raw product have led to the consideration of using non-tobacco materials as supplements in the manufacture of cigarettes. For example, cigarettes containing supplemental materials have been introduced in West Germany and Switzerland and a similar material is being made in the United States. ARS production research, including a new curing technique, the homogenization of ripe tobacco leaf, is aimed at providing alternative means to attaining similar goals of safer products at lower costs. At the same time, tobacco flavor and aroma, lacking in these new synthetic smoking materials, may be retained.

QUALITY IMPROVEMENT

In studies at Tifton, Georgia, yield, quality and usefulness of flue-cured leaf were not impaired by harvesting the crop in four primings instead of the normal six or seven. At the same time, efficiency was improved and costs reduced. However, reducing the number of primings to three caused a slight reduction in yield and quality.

At Oxford, North Carolina, the development of an automated method to determine amounts of polyphenols made it possible to select for low polyphenol content in the breeding program. This is important because tobacco smoke containing high levels of catechols derived from polyphenols has caused an increased number of tumors in mouse back painting tests.

Also at Oxford, a statistical formula based upon chemical constituents of leaf was developed and used to predict tar levels of 1,500 different tobacco strains and varieties. Nicotine and tar levels were actually determined from selected varieties and cultural practices. Tar ranged from 19.71 mg per cigarette in leaf of Coker-187 Mammoth to 35.84 in TI-1335. Nicotine ranged from 0.46 in LAFC 53, not topped, to 4.73 in TI 1335. Nicotine and tar increased when plants were topped and suckers removed. Topping and suckering are traditionally associated with heavier body, flavor, and aroma. However, neophytadiene, a terpenoid hydrocarbon, which improves flavor and aroma of smoke, was not associated with nicotine levels.

The root system of variety NC-95 was more efficient than the root system of a low alkaloid flue-cured line (LAFC-53) based on amounts of total nitrogen and nicotine in the leaf. This conclusion was borne out in evaluating reciprocal grafts between NC-95 and LAFC-53. The chemistry and behavior of NC-95 scion developed on LAFC-53 root stock was more like LAFC-53 than NC-95. Conversely, the LAFC-53 scion developed on NC-95 root stock was more like NC-95.

Bulk-cured detached leaves of burley tobacco at Lexington, Kentucky, received lower Federal grades than did leaves from stalk cut air-cured burley. Also, free amino acids and sugar contents were higher and buildup of ammonia and nitrate during early stages of the cure were lower for the bulk-cured leaf. These differences suggest oxidative processes that occur during normal air curing of stalk-cut burley were not as complete when leaves were primed and bulk cured.

Differences in chlorophyll content among flue-cured and burley tobaccos was responsible for major chemical differences between varieties of the two types. When differences due to chlorophyll content were removed, chemical variation was similar among varieties of both types.

As part of an extramural project at Lexington, Kentucky, the Leaf Analysis Laboratory performed approximately 14,500 analysis for various project investigators. Specific analyses performed were total nitrogen, total and individual alkaloids, nitrate nitrogen, total volatile bases, cellulose, petroleum ether extractables, total and reducing sugars, protein nitrogen, total free amino acids, individual amino acids and moisture. In FY 1976, the laboratory cooperated with the Tobacco and Health Statistical Services in evaluating the accuracy and precision of the laboratory methods. All the methods were considered to be satisfactory except one test for alkaloids. Additional research is underway to improve the precision of this procedure.

As a cooperative endeavor between scientists at Oxford, North Carolina, Beltsville, Maryland, and the National Cancer Institute, large samples of homogenized cured leaf and normal flue-cured tobacco were produced at Oxford. These samples will be used to evaluate the chemical and biological differences resulting from normal flue-curing and homogenized leaf curing.

HOMOGENIZED LEAF CURING

At Oxford, North Carolina, mature tobacco plants, grown at 40,000 plants per acre instead of the normal 7,000 were cut with a forage harvester and transported in a movable-bed forage wagon to a pilot plant for further refinement of the coarsely-chopped leaf. The chopped leaf material was finely ground with a hammermill into a wet pulp slurry. Water containing sodium metabisulfite as an antioxidant was pumped into the chamber to

wash the tobacco through the mill. When the slurry was stored in stainless steel tanks under partially anaerobic conditions the tobacco yellowed and no microbial action occurred. Refrigeration was not needed to preserve the material in tightly sealed containers. Fluid bed drying proved to be more convenient than vacuum drying, and quality of the product was better.

At Lexington, Kentucky, protein content of homogenized leaf was influenced by varieties and plant populations. Protein content decreased as plant populations were increased from 5,400 to 43,500 plants per acre. Among four varieties, protein content was highest for KY-14 and Experimental Line 100, and lowest for Warner and VA-B29. Leaves contained more protein and nicotine than stalks.

Small amounts of Fraction-1-Protein (F-1-P) have been separated from cell sap of tobacco leaf during the homogenized leaf curing procedure. Based upon amino acid content, F-1-P is nutritionally equal to milk and superior to soybeans.

CHEMICAL RIPENING

The ethylene-releasing agent, 2-chloroethylphosphonic acid (ethephon) has been registered for use as an aid for harvesting and curing flue-cured tobacco. Initial work with the chemical as a tobacco ripening agent was conducted at Beltsville, Maryland, and at Tifton, Georgia.

In continuing work at Tifton, Georgia, ethephon applied on mature tobacco plants prior to the third priming hastened the rate of yellowing, harvesting, and curing of the remaining leaves. Harvesting was completed 4 weeks earlier than the untreated tobacco, and curing time was reduced by 30 percent which cut fuel and electric costs. Agronomic characteristics and smoke flavor and taste were not significantly affected, although analytical values did show a slight decrease in total alkaloids, total ash, alkalinity number and filling value, and some increase in the sugar content of cured leaves from treated plants.

In field tests conducted from Raleigh, North Carolina, the yellowing agent, ethephon, was applied at two stages of leaf maturity. Treated tobacco was lower in agronomic parameters, total alkaloids, and total volatile bases minus nicotine. Reducing sugars were increased. Leaf from the later ethephon application probably would be preferred by tobacco leaf dealers.

As part of the Regional Growth Regulator activities conducted at Greeneville, Tennessee, ethephon applied at the rate of 150 mg per plant accelerated ripening of burley tobacco, but reduced the yield.

DEVELOPING DISEASE RESISTANT VARIETIES

Resistance to a new virulent race of the wildfire bacterium is being incorporated into tobacco breeding lines at Beltsville, Maryland. Resistance comes from two wild relatives of cultivated tobacco, Nicotiana rustica and Nicotiana repanda, but most progress has been made with resistance from N. rustica. This new race of wildfire occurs occasionally on burley tobacco but has caused most damage on cigar tobacco in Wisconsin.

N. repanda also is the source of resistance to a leaf spot caused by the fungus Cercospora nicotianae. A high proportion of the progeny was resistant after several crosses to cultivated tobacco and following four generations of self pollination.

Black shank-resistant burley and etch-(a virus disease) tolerant Maryland type tobacco were crossed at Beltsville and some of the progeny performed well when grown in Pennsylvania in the presence of these diseases. A late generation cigar filler breeding line resistant to mosaic, black root rot, and wildfire, and low tolerance to etch, is being considered for release as a variety in Pennsylvania. Etch and mosaic are caused by different viruses and the other diseases, respectively, by a fungus and a bacterium. Two pollen sterile cigar wrapper breeding lines resistant to the blue mold fungus and mosaic virus have been made available by ARS tobacco breeders at Beltsville to commercial cigar wrapper tobacco breeders.

Tobacco introductions have provided new sources of resistance to blue mold, black root rot, and Alternaria leaf spot. The use of haploids derived from the culture of anthers on artificial medium is being used to accelerate the incorporation of Alternaria leaf spot resistance into locally-adapted cultivars. This technique makes it possible to develop stable tobacco lines in 18 months to 2 years instead of the normal 6 years by conventional breeding practices. However useful varieties have not yet been developed by this rapid breeding procedure.

At Greeneville, Tennessee, and Lexington, Kentucky, progress is being made in transferring resistance to etch and tobacco vein mottling viruses into burley tobacco from a strain of tobacco called Virgin A mutant. These two viruses are serious in burley production areas. Strains of burley tobacco resistant to mosaic, wildfire, Fusarium wilt, and black root rot following crosses to Virgin A mutant remained free of disease when inoculated with etch and vein mottling viruses. Results are encouraging that resistance to etch and vein mottling viruses can be combined with resistance to the other diseases.

At Greeneville, Tennessee, performance of black shank-resistant burley varieties was improved by treating either black shank-infested or disease-free soil with soil fungicides or nematicides. Also, over a 7-year period under continuous culture of black shank-infested soil with resistant varieties, no new races of the black shank fungus could be detected.

SEEDLING PRODUCTION

Premature flowering is a serious problem resulting in uneven growth and reduced yields during some years. In studies at Lexington, Kentucky, floral induction in seedlings of one tobacco variety occurred as early as the four-leaf stage. Another variety responded at the seven-leaf stage, and five other varieties were intermediate. An ethylene releasing formulation applied to seedlings during rainy, overcast conditions resulted in better transplants, later flowering, more leaves per plant, and greater uniformity in the field.

Also, seed size was found to influence germination and seedling vigor. Heavy seeds germinated at the same time and produced vigorous seedlings that grew uniformly in the field. Smaller seeds germinated at various intervals and the seedlings continued to lag in growth after transplanting into the field.

At Greeneville, Tennessee, in tests with different materials, nylon, woven plastic, and polyester were equal to or better than the conventional cheesecloth plant bed covers in the production of tobacco seedlings. Knitted cotton and plastic with 3/4-inch holes were inferior to cheesecloth.

SUCKER CONTROL CHEMICALS

The Ad Hoc Regional Tobacco Growth Regulator Committee evaluated a growth regulator mixture consisting of maleic hydrazide and fatty alcohol on all major tobacco types, and found that the mixture passed all requirements as a sucker control agent. In addition, the use of a synthetic chemical (MBR 12325) combined with maleic hydrazide has shown additive, and in some cases, synergistic effects.

At Tifton, Georgia, a commercial mixture of N-Decanol and maleic hydrazide (MH) when applied at the rate of 18 quarts per acre gave 85 percent control. In research to find new sucker control chemicals, moniliformin, a natural product from the fungus Fusarium moniliforme, showed promise. Limited field trials with synthetic moniliformin competed with maleic hydrazide in inhibition of sucker growth. At 21 days, yields of suckers by weight and expressed as ratios of MH:Moniliformin:Control were 1:2:7:.

The use of carefully-directed sprays toward the leaf axle area, either of maleic hydrazide or fatty alcohols, were very effective in controlling tobacco suckers in research conducted at Raleigh, North Carolina. In the case of maleic hydrazide, less leaf area was wetted with the spray resulting in potentially lower residues of the chemical.

Results with a dinitroaniline contact-type sucker controlling agent showed that at least 200 mg per plant were necessary to obtain sucker control. At rates higher than 200 mg per plant, residual effects were noted in the soil in succeeding crops. For example, the germination of wheat was reduced when used as a cover crop following tobacco.

Some 45 plant extracts from a collection of 450 species of higher plants have shown potential as tobacco sucker control agents in research in the Growth Regulator Laboratory at Beltsville, Maryland. Camptothecin, an extract from Camptotheca acuminata inhibited axillary bud growth of Xanthi-nc and Connecticut Broadleaf tobacco at concentrations of 10^{-4} M. No adverse effects were noted on the expanding leaves. Also, a potent tobacco growth inhibitor has been isolated from Cephalotaxus (Taxaceae) and has been characterized as a terpenic ketolactone. Extracts from Celastraceae and Euphorbiaceae have been found to contain growth regulating compounds active on tobacco.

NRP Annual Report
FY 1976

NRP 20080 Breeding and Production--Soybeans, Peanuts, and Other
Oilseed Crops

NPS Contact: R. C. Leffel

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Technological Objectives 1 and 2 for each of the Sub-Programs: Soybeans, Peanuts, Flax, Sunflower, Safflower, and Guar, as follows:

T01 - New and improved genetic populations, breeding lines, and varieties of oilseed crops that combine improved yield potentials and favored quality characters, including reduced contents of undesirable constituents, with better resistance to pests, tolerance to environmental stress, and adaptation for mechanized culture, harvesting and handling.

T02 - New and improved cultural and management practices that increase oilseed crop yields, minimize production losses, improve quality attributes and conserve and use scarce resources efficiently.

Progress Reports by Species, T0, and Locations

Soybeans - T01

Beltsville, MD: (R. C. Leffel, T. E. Devine, R. G. Orellana) - The Mid-Atlantic area and National regional soybean variety testing programs continued to identify superior new varieties. D66-5566 will be considered for release during the summer of 1976; V68-1242 will be considered for release for 1977. Md 70-2221 and Md 71-407 are also especially promising and are being increased in 1976 for possible future release. Seed yields of determinant early varieties did not exceed those of indeterminate early varieties in narrow row, high population field plantings (35 bu/A range). A cooperative photoperiod study with Field Crops Laboratory confirmed that resistance to Mexican Bean Beetle is highly correlated with later plant maturity. Cooperative field studies with Nematology Laboratory indicated increased seed yields and decreased nematode populations with nematicide treatments. A cooperative field study with Plant Stress Laboratory showed no yield advantage of seed from plants produced in an air pollutant-free environment. A cooperative field study with Plant Hormone and Regulators Laboratory indicated no effect of brassin-treated seed in subsequent seed yields.

An improved solution culture technique was devised for determining root response to Al stress. Genotypes of Rhizobia were identified with a limited degree of infectivity on soybean genotypes excluding infection by indigenous less-efficient strains.

The effect of Rhizoctonia on nodulation and nitrogen fixation in soybeans was studied. Rhizoctonia solani significantly reduced top and nodule weights of 'Lee' and 'Kent' soybeans inoculated with Rhizobium japonicum as compared Rhizobium alone. For Lee soybean, a 63 percent decrease in N_2 fixation per plant due to the fungus was demonstrated. In Rhizobium-inoculated Kent soybean grown in the presence of Rhizoctonia at either 15, 20, or 25°C, total nitrogen content was also reduced. The fungus was found to cause nuclear degeneration in the Rhizobium-containing cells of the central tissue of young nodules. This finding supports the concept that nodule cell dysfunction may interfere with the symbiotic nitrogen fixation process.

Raleigh, NC: (C. A. Brim and J. W. Burton) - A third cycle of recurrent selection for yield showed a 17 percent increase over the base population. The base population and subsequent cycles were all higher in yield than a strain highly adapted to the Southeast. Parents for the sixth cycle of selection for high protein averaged 49 percent protein and 16 percent oil compared with 47 percent and 17 percent in the base population. Contrary to the usual inverse relationship between high protein and high yield, lines from the sixth cycle were 24 percent higher than the base population and equivalent to the mid-parent value for yield. Further, individual selections from the sixth cycle had a protein content of over 50 percent. Plants from the fourth cycle of selection for oil percent averaged 23.7 percent, five of these had over 25 percent oil. This represents an oil content higher than that found in the world soybean collection. Mass selection among male sterile plants in the field and within family selection in the greenhouse is being followed in this population. The second cycle of recurrent selection for low linolenic acid content showed an 8 percent decrease (7.6-7.0) in this undesirable component of soybean oil. Oleic acid content remained at a very high level (40 percent as compared with 20 percent for adapted cultivars). An experimental line resistant to a new race of the soybean cyst nematode was evaluated for potential as a cultivar in North Carolina. This line should provide additional stability of production for North Carolina growers. Experimental lines from advanced tests exceeded the check varieties for yield. For example: N72-137 yielded about 5 bushels higher than Lee-74 (47.2 vs. 42.4 bu/A); N72-3154 and N72-3189 exceeded 'Bragg' over 5 bu; and N73-520 'Hill' by about 10 bu/A.

Gainesville, FL: (K. Hinson) - From about 700 breeding lines evaluated in 1975, 200 were selected as being potentially superior to existing cultivars in yield, protein content, disease resistance, or other desirable traits. One selection (F71-1180) yielded 9.6 percent more than Bragg (the most widely grown U.S. cultivar in 1974 and 1975) and 7.5 percent more than 'Ransom' in tests at six East Coast and 11 Southeastern U.S. locations. It appears to equal Bragg and to exceed Ransom in pest resistance. We selected nearly 300 lines with apparent resistance to both Meloidogyne incognita and Heterodera glycines for agronomic evaluation; selected for individual and multiple pest resistance in other segregating populations, and selected late maturing, tall growing genotypes to evaluate their potential for a second crop following field corn. The latter are expected to have adaptation to tropical environments. Crosses were made to incorporate more acceptable edible traits into late maturing genotypes. Backcrossing programs to

incorporate late flowering and small seed into predominantly Bragg and 'Cobb' germplasm were initiated.

Stoneville, MS: (E. E. Hartwig, B. L. Keeling, T. C. Kilen, C. J. Edwards, Jr. W. J. Russell, L. G. Heatherly) - The breeding line D70-3185 is being increased for release as a variety. D70-3185 is a highly productive line resistant to major foliar diseases, Phytophthora rot, races 1 and 3 of the soybean cyst nematode, root knot, and reniform nematode. Although 10 States are cooperating in the release of this variety, it will fill a special need in the west Florida-south Alabama production area where cyst and root knot nematodes are a problem in many fields. D70-3185 is 2 weeks later in maturity than 'Forrest', which is the only variety now available which has this combination of nematode resistance. Advanced lines resistant to race 4 of the soybean cyst nematode were evaluated in replicated trials. Several equalled Forrest in seed yield on soil infested with race 3 and where no nematodes were present. The best of these will be more widely tested in 1976.

The variety 'Tracy' has proved to be resistant to all of the known races of Phytophthora rot. Genetic studies are in progress to determine the genetic basis for resistance to races 1 through 6. The sensitivity to the herbicide metribuzin carried by Tracy appears to be inherited as a simple recessive. An F₂ population of 'Davis' x PI 229358 was grown in the greenhouse in the winter and infested with soybean looper. Plants were grown to maturity and a single 10-seed hill grown from each F₂ plant in a field cage which was infested with soybean looper. Agreement between greenhouse and field cage ratings was good. It appears that F₂ populations may be screened in the greenhouse, and susceptible lines discarded with little danger of discarding resistant lines. Advanced breeding lines selected for resistance to several foliar-feeding insects were evaluated in a field cage against soybean looper and in replicated tests for yield. Several appear to have good agronomic qualities along with their resistance to foliar-feeding insects. The better lines are also resistant to the major foliar diseases, Phytophthora rot, and root knot nematodes.

Lines selected for higher protein content of the seed have been given good productivity. D72-8105 equalled Lee 74 in seed yield in regional tests and produced 12.5 percent more protein per acre. D74-7445, grown only at Stoneville, equalled Forrest in seed yield, 46.5 bu per acre, but produced 25 percent more protein per acre. These high protein lines are correspondingly lower in oil. Breeding lines susceptible to soybean mosaic virus when inoculated with SMV were reduced in yield 8 percent. However, paired resistant-susceptible closely related lines did not differ in yield when grown at eight locations in the State. These results suggest that SMV is not a yield limiting factor in the State. Approximately 1000 new introductions, primarily from Korea and Japan, have been added to the germplasm collection.

Lafayette, IN: (J. R. Wilcox and T. S. Abney) - Heterosis and combining ability among 12 soybean strains from the following origins: locally adapted, Manchurian, Chinese, and Korean, were evaluated from 30 F₁ combinations, involving these strains. Heterosis for yield was greater than that for any other character, averaging 8.0 percent over the high parent for 2 years.

Twelve of the 30 hybrids outyielded the midparent. Number of pods per plant was the most heterotic of the yield components. Number of seeds per pod and seed size of the F_1 's was, with few exceptions, intermediate to parental values, as were maturity, height, lodging, and harvest index. Heterosis for plant weight was similar to that for yield, both in magnitude and in the hybrids expressing it. Significant GCA effects were found for all characteristics. SCA effects were significant for seed size, maturity, and height. Years x GCA was significant for yield, number of pods per plant, maturity, lodging score, plant weight, and harvest index. Years x SCA was significant for number of seeds per pod, maturity, lodging, and harvest index. Soybean plants in the F_2 , F_3 , and F_4 generations from the cross 'Amsoy' x PI 80837 were inoculated with Cercospora kikuchii, the causal organism of purple seed stain. Incidence of purple seed stain averaged 84.3, 28.4, and 85.7 percent on Amsoy and 2.8, 0.2, and 2.3 percent on PI 80837 during the 3 years of the test. Heritabilities for disease incidence were 0.91 in the F_2 and 0.51 in the F_3 generations. Predicted response to selection closely approximated observed gains, when the most resistant 10 percent of the plants in each generation were evaluated in the next generation. Since the disease has not been shown to adversely affect agronomic characteristics, selection against extreme susceptibility seems more appropriate than intensive selection for a high level of resistance to the disease.

Fungal colonization of soybean pods and seed in field studies was investigated by determining percent pod infection, pod colonization indices, and percent seed infection at selected intervals beginning at early pod development and extending beyond harvest maturity. Fungi previously unreported on soybean pods and/or seeds include species of the following genera: Ophiobolus, Cephalosporium, Pleurage, Thielavia, Sporomia, Fusarium, Chaetomium, Botrytis, Helminthosporium, Papularia, Periconia, Coniothyrium, and Phoma. Studies involving the effect of temperature on fungal colonization of soybean pod and seed demonstrated that temperatures above 20°C favored rapid Diaporthe spp. colonization of seed, whereas colonization was somewhat slower at 10°C and 15°C with incubations of 6 to 10 days required for establishment of Diaporthe spp. in 30 percent of seed, and very little colonization of soybeans at 5°C. Soybean cultivars inoculated with BPMV and SMV exhibited differential foliage and seed coat mottling reactions. Seed mottling caused by BPMV was somewhat similar to SMV seed mottling in several cultivars although suggestive of a "smoke" colored saddle pattern in some cultivars. Prevalence and severity of soybean diseases in Indiana in general were higher in 1975 than in 1974.

Urbana, IL: (R. L. Cooper, R. L. Bernard, L. E. Gray, W. L. Ogren, R. W. Rinne)

Breeding and Genetics: Averaged over locations, one of the best semidwarf soybean lines, L74D611, has had a 3-5 bu/A advantage over the check variety, 'Williams,' in 30-inch rows and a 5-10 bu/A advantage in 7-inch rows. It is approximately one-half the height of Williams and has much greater lodging resistance. This line was increased in the Puerto Rico winter nursery and has been entered in the Uniform Regional Trials in 1976. Approximately 3 years is being increased for the potential release as the first semidwarf variety in July of 1977. Completed an 8-year isoline study in the varieties 'Harosoy'

and 'Clark,' demonstrating two growth stimulating genes Pd and Rps₁ significantly increased the yield of determinate isolines of these two varieties while significantly decreasing the yield of the normal indeterminate lines. These results indicated that increased lodging in the indeterminate types was the major factor preventing the anticipated yield increase from these growth stimulating genes. A third gene studied, narrow leaflet, tended to decrease vegetative growth and yield in both indeterminate and determinate types. Results of this research indicate that the isoline approach for evaluating the agronomic worth of a specific gene or trait has limitations because of the significant interaction of specific genes with different genetic backgrounds. Have continued evaluation of early generation testing as a breeding method in soybeans. The semidwarf line being increased for potential release was developed by this procedure. In addition to L74D611, an array of other high yielding semidwarf pure lines have been selected out of the same original high yielding F₂ derived line, ranging in maturity from 14 days earlier to 3 days later than L74D611. The major advantages of early generation testing are early identification of superior crosses (in the F₃) and identification of those F₂ plants within these crosses which received the best compliment of yield genes. This enables the plant breeder to concentrate his efforts on the best crosses and best F₂ derived populations within these crosses. In the regional testing program 27 entries were entered in the preliminary tests and eight entries in the Uniform Tests. Of these lines six have been advanced for further testing in 1976. In addition, 20 new lines including 11 semidwarf lines have been entered in the regional test this year. Fully standardized the Neotec Infrared (IR) analysis techniques for determining oil and protein percentage in soybean seed samples. Provided IR analysis for 10,000 experimental soybean seed samples submitted to the U.S. Regional Soybean Laboratory for protein and oil analyses by plant breeders and other publicly supported research scientists throughout the United States and Canada. An additional 1500 NMR analyses were made for oil determinations. Kjeldahl nitrogen was determined for approximately 500 plant samples. Some 680 samples were analyzed for oil by Butt Extraction and 480 samples analyzed for protein by Kjeldahl, to be used as standard samples in calibration and monitoring of the IR and NMR analyses. Participated in a regional standardization test on approximately 100 samples. Tested different grinding methods as they influence IR readings. Ran 36 soybean lines for amino acid analysis.

The top yielding experimental strain in each of Uniform Tests II, III, and IV in 1975 was from this program and these will be tested further in 1976. The three determinate entries (dt₁) from this program in Uniform Preliminary Test IV yielded midway among the 24 indeterminate entries and were distinctly above the pertinent check variety 'Culter 71' in average yield. Both lodging resistance and seed quality averaged better than for most of the indeterminate strains. About 1100 new Japanese varieties, 576 new Korean ones, and 56 from China were grown for the first time preparatory to adding them to the germplasm collection. Over 1300 old introductions were grown for seed increase. Five hundred progenies of recently introduced wild soybeans from Japan, Korea, and China were grown here and at Stoneville, MS, and 293 of them were added to the collection giving a total of 361 strains in the wild soybean collection. Over 200 breeding lines with resistance to

the Mexican bean beetle were screened in cooperation with entomologists in Indiana and Maryland, and plants were selected from the best lines for growing in 1976 and for backcrossing in the winter greenhouse. Over 700 lines with cyst nematode resistance, selected for resistance from a much larger group of lines, were grown and visually selected for yield-testing in 1976. Over 3500 lines from populations made for general agronomic improvement, but including special traits such as high protein, growth types with improved lodging resistance, and *Phytophthora* rot resistance, were grown and visual selections made for yield testing in 1976. A number of BC isolines, involving genes affecting growth type and the recurrent parents 'Harosoy,' 'Clark,' 'Wayne,' and 'Williams' were performance tested in replicated plots and will be further tested and released as germplasm for breeding and research.

Pathology - Pathogenic isolates of *Phomopsis* sp. have been isolated from soybean plants collected from Illinois and Missouri. Preliminary greenhouse tests have shown that many isolates cause a severe root rot of soybean plants. Soil temperatures of 25 to 30°C are necessary for severe root rot development. *Mycoleptodiscus terrestris* has been isolated from roots and crowns of soybean plants from central and southern Illinois the past 4 years. This fungus causes a seedling root and crown rot of soybeans; the root rot symptoms on soybeans are identical to those caused by *Rhizoctonia solani*. Soil moisture and temperature are important factors that determine the extent of damage to soybean plants. A screening technique for determining resistance of soybeans to *Macrophomina phaseolina* (charcoal rot) has been developed. So far 100 soybean lines have been screened for resistance by this technique. Micro-fumigated field plots have been used for the past 2 years to study soybean root rot severity in the field. Small plots are fumigated with methyl-bromide to reduce the level of soil-borne pathogens. In 1975 plant maturity was delayed 10 to 14 days in fumigated plots compared to plants in nonfumigated plots. PI 181.550 has shown good resistance to Pod and Stem Blight in central and southern Illinois for the past 3 years. Seed infection of PI 181.550 has not been more than 5 percent compared to 10 to 70 percent infection of commercial varieties. F₃ and F₄ generation are being evaluated for resistance. Downy mildew has become an important foliar disease of soybeans under double-cropping conditions where soybeans are planted in wheat stubble. Defoliation occurs during pod fill, and at maturity there is a high incidence of mildew-infected seed. F₂ lines are being evaluated for resistance.

Photosynthesis - The carboxylase and oxygenase activities of purified soybean ribulose 1,5-di-P carboxylase were unstable when reactions were initiated with enzyme. Double reciprocal plots of amount of CO₂ incorporated and P-glycolate produced vs. time were constructed to determine a constant representing the half-time of initial enzyme activity. This constant increased with increasing bicarbonate concentration but was independent of O₂ tensions between 0.21 and 5 atm. The observed bicarbonate-dependent decline in ribulose 1,5-di-P carboxylase activity with time is the probable cause for the anomalously high Km(CO₂) values previously reported for this enzyme. The interaction between bicarbonate and enzyme may be important in the light activation of photosynthetic CO₂ fixation in vivo. The Km(CO₂) values of ribulose 1,5-diphosphate carboxylase in freshly ruptured spinach

chloroplasts and in the purified form, isolated from spinach leaves, were found to be pH dependent. Raising the pH of the assay solution produced a substantial decrease in the $K_m(\text{CO}_2)$ of both enzyme systems. The maximum velocity for both enzyme systems at optimum substrate levels was at pH 8, but the highest calculated rate of CO_2 uptake at atmospheric CO_2 levels occurred at pH 8.8. These results support the proposal that the light-induced efflux of protons out of the chloroplast stroma may be a major factor in the in vivo light activation of carboxylase. A technique for isolating photosynthetically active soybean mesophyll cells was developed.

Protein and Oil Synthesis - Freezing of plant tissue adversely affects lipid composition. Immature soybean cotyledons (Glycine max L. Merr.) var. 'Harosoy 63' were frozen with liquid N_2 , dry ice, or stored in a freezer (-20°C) before lipid extraction. The effects of freezing temperature, thawing rate, and cold storage on the lipid composition of frozen tissue revealed significantly higher levels of phosphatidic acid, and diminished levels of phosphatidylcholine, phosphatidylethanolamine, and N-acylphosphatidylethanolamine from the control. Regardless of freezing temperature, phosphatidic acid levels increased from 4.7 mole percent to nearly 50 mole percent of the total phospholipid when frozen tissues were stored 10 days at -20°C . During the same period, N-acylphosphatidylethanolamine decreased from 54.1 mole percent to 6.6 mole percent phospholipid. In autoclaved samples, phosphatidic acid, phosphatidylcholine, phosphatidylethanolamine, and N-acylphosphatidylethanolamine levels were not different from the control. Apparently enzymic destruction of the phospholipids occurred during freezing, cold storage, and thawing. Therefore, high moisture tissue must be extracted immediately if an accurate phospholipid determination is desired. The metabolic activity of individual lipid classes found in developing soybean cotyledons was estimated by determining the degradation rate of the compound under given conditions. Pulse-labeling and dual substrate labeling were used to evaluate this parameter. These studies indicate first order decay kinetics for phosphatidic acid, phosphatidylinositol, phosphatidylcholine, phosphatidylethanolamine, N-acylphosphatidylethanolamine, diglyceride, and zero order kinetics for triglyceride in cotyledons var. 'Harosoy 63' at 30 days after flowering. Decay coefficients for acyl groups and lipid-glycerol moieties within specific lipid classes from either method were comparable. Half-life calculations from the decay coefficients indicate extremely rapid turnover rates and suggest similar turnover rates of acyl groups and lipid-glycerol in diglyceride and all phospholipids except N-acylphosphatidylethanolamine where acyl groups are replaced independently of the glycerol moiety. These experiments reveal not only different metabolic activity between lipid components of soybean cotyledons, but also describe a new method of measuring lipid turnover in plants.

Columbia, MO: (V. D. Luedders and M. R. Gebhardt) - The mutation from yellow to colored seed coat generally had no effect on the protein and oil content of 17 cultivars although the increase or decrease was significant in a few instances. Laboratory germination and field emergence were not affected. In other beans, colored seeds have better field emergence. Dry-matter yields of soybeans (Hill) and grass compared to grass alone were 9085 and 1370 kg/ha when the soybeans were planted into a grass sward on

May 22 and harvested on September 30. This is equivalent to hay yields (13 percent moisture) of 4.7 and 0.8 tons/A. Yields were less with other soybean lines and from the June 18 planting. When paraquat was used to suppress grass, the highest seed yield of Williams soybeans was 29 bu/A. When detached petioles were wound inoculated with *Phytophthora* and incubated in the light in a growth chamber, the succulent terminal part of the petiole gave the same reaction as would be expected on the cultivars hypocotyl. Our current cultivars are the result of essentially two cycles of selection. Seed yield increased about 5 Bu/cycle and lodging decreased. When soybean pods were moistened and incubated at 5, 10, 15, 20, and 25°C for up to 10 days, seed infection by *Alternaria* and *Diaporthe* increased and germination decreased with increase in temperature and length of incubation time.

Ames, IA: (J. M. Dunleavy, H. Tachibana, R. G. Palmer, K. Sadanaga) -

Genetics and Cytogenetics: We have located the genes w, (white flower), w^m, (magenta flower), and ms, (male sterility), to one of two chromosomes from the translocation of Clark x P1101.404A. We have shown that the genetic traits t, w, ep, y_{cd}, and Y"y" are not located on any of the three primary trisomics.

Brown Stem Rot: One of three brown stem rot (BSR) resistant soybean lines was advanced into the Regional Soybean Uniform Test (UT) for 1976 from the Uniform Preliminary Test (UPT) in 1975. The BSR resistant line (A74101035) is the first to advance into UT based upon yield performance on both infested and non-infested land. The two BSR resistant lines (A74305021 and Ax899-6-1) rejected for further evaluation because yields were low, are noteworthy in that they were highly resistant to both BSR and *Phytophthora megasperma* var. *sojae*. Resistance ~~was~~ selected for *Phytophthora* along with that for BSR because both diseases have become a common problem in the research plots and commercial fields. Five additional BSR resistant lines subsequently developed and found to be more superior than recent new varieties, were entered in UPT for 1976. Thousands of plants from three populations were screened and hundreds of lines were selected and advanced for further yield tests.

Host-Parasite Relations. Pustule bacteria (*Xanthomonas phaseoli* var. *sojensis*) isolated from the downy mildew fungus (*Peronospora manshurica*) may achieve pathogenicity through secretion of highly oxidative hydrogen peroxide (H₂O₂). Two pustule isolates were tested for H₂O₂ production at temperatures from 10 to 35°C. Little or no H₂O₂ was produced in 2 weeks at 10 to 25°C, production at 30°C was significant and the most H₂O₂ was produced at 35°C.

Peroxidase is an inducible enzyme in soybeans, that converts H₂O₂ to water. Peroxidase was assayed in downy mildew-infected soybean plants grown at 15, 20, and 35°C. Disease symptoms were most severe at 20°C and the highest peroxidase levels reached at the respective temperatures tested were 42, 150, and 28 units/gm of tissue. The peroxidase levels in healthy plants grown at the same temperatures were 13, 28, and 19 units/gm of tissue, respectively.

Brookings, SD: (C. B. Dybing) - Evaluation of soybean lines from the U.S. Regional Soybean Laboratory to find lines having racime length and photoperiod sensitivity suitable for use in abortion studies showed the most promising lines to be T-171, Clark isoline E₁te₂, Essex, and L66.531. Techniques were developed for in vitro measurement of transport of C¹⁴ in soybean racimes. Upward movement of sucrose into fruits was detected in 3 to 6 hr for soybean.

Davis, CA: (B. H. Beard, J. M. Klisiewicz, A. L. Urie) - Yield tests of 46 midwest varieties indicated those best adapted to the environmental conditions at Davis. From these tests and others in Hawaii, five varieties have been selected for use as parents in the crossing program and checks in future yield tests. Spider mite resistant lines were grown in the field and observed for agronomic characteristics. No line was discarded but some are superior in yield and other agronomic features. At least two lines shatter before normal harvesting is possible. The day-length insensitive lines were grown in the field for seed increase and observation. These also vary for yield and agronomic characteristics. Two of these shatter early. Two additional day-length insensitive lines were received from Taiwan. These have been grown in the greenhouse and used as parents in crosses. Earlier attempts at crossing different varieties or lines have been only marginally successful but during this year we have learned how to grow healthy plants in the greenhouse and successfully cross varieties and lines. One hundred-eighty crossed pollinations produced seed. One seed from each cross was planted in the greenhouse at Davis and about 70 of these are true crosses about 100 cannot be determined in F₁, and 10 are not crosses. Additional seeds (124 crosses) of these crosses were planted in Hawaii. There are also 303 progenies of F₂ plants growing in Hawaii which will be harvested in FY 1976.

Soybeans - T02

Beltsville, MD: (D. F. Weber and C. Sloger) - Inoculation trials on 'Essex' and 'York' at Wye Institute and on 'Kent' at Beltsville with four highly efficient nitrogen-fixing strains of Rhizobium failed to increase seed yield over that of uninoculated control of Rhizobia-populated soils. Inoculation trials with Rhizobium japonicum strain 94 on Lee soybeans in Rhizobia populated soil at Beltsville have shown that indigenous Rhizobia populations can be shifted if environmental conditions favor the strain added as inoculant. Rhizobium induced chlorosis was demonstrated on the Lee variety by adding strain 94 during elevated soil temperatures which are favorable to its competitive competence. Accessions of R. japonicum from India proved competitive with low populations of contaminating Rhizobia and showed continued superiority over efficient strains of Rhizobium from the Beltsville Culture Collection in inoculation trials at Upper Marlboro.

ATP is a critical physiological regulator of nitrogenase activity in soybean root nodules. The ATP concentration of freshly detached nodules from greenhouse grown soybeans was 1.2×10^{-7} moles per gram nodule fresh weight. A rapid decrease in nitrogenase activity of freshly detached nodules over a 3-hour period was correlated with a similar rapid decrease in ATP content

of nodules. The sensitivity of the nitrogenase activity of nodules to detachment reflects ATP changes which may be due to changes in oxygen permeability, water content, and interrupted flow of photosynthate. One hour after detachment of nodules nitrogenase activity decreases 75 percent while ATP concentration decreases 60 percent. When soybean plants were placed in the dark for 2 days the nitrogenase activity decreased 80 percent and the ATP content of root nodules decreased 70 percent. Nitrogenase activity is dynamically linked to energy production within the root nodules.

Nitrogen input by symbiotic N_2 fixation by field grown soybeans was monitored by the acetylene reduction and ^{15}N -tracer method. The amount of nitrogen fixed, according to the acetylene reduction and ^{15}N tracer methods, was 103 and 110 lbs N/a indicating good agreement. The amount fixed represented 60 percent of the total nitrogen in the mature plant. Symbiotic N_2 fixation per plant was most active during bean development. The ^{15}N tracer method indicated that 90 percent of the fixed nitrogen was in the mature seed. Most (90%) of the nitrogen was fixed after plants flowered (R1 stage). Nitrogenase activity declined markedly during periods of low soil moisture.

Raleigh, NC: (J. P. Ross) - Soybean yield losses caused by soybean mosaic virus (SMV) ranged between 9 and 21 percent in field experiments using SMV-resistant and susceptible sister lines selected from progeny from a backcrossing program to four soybean cultivars. By incorporating SMV resistance into 'Pickett 71' (soybean cyst nematode resistant), yields were increased 27 percent over those of Pickett 71. Two aerial applications of the fungicide, benomyl, to field plots of Essex and Lee 68 produced no significant yield increases. In evaluations of 220 Plant Introductions of Maturity Group V for resistance to *Cylindrocladium* red crown rot of soybean conducted in an artificially infested soil, all but 42 lines were considered susceptible. Studies were initiated on the competition and interaction of two species of arbuscular mycorrhizal fungi on peanut and soybean.

Gainesville, FL: (K. Hinson) - Data on three completed experiments were published. All results relate to the nitrogen nutrition of soybeans. Important findings include: (1) Nitrogen applied to one portion of a soybean root system can influence the size of nodules on the untreated portion of the same root system, (2) Nitrogen responses measured by plant weight of seedlings in greenhouse pots do not reliably indicate N responses in seed yield of field plots, (Many previous investigators had drawn seed yield conclusions from seedling data), (3) Over a 4-year period, seed yield responses to N fertilizer were small or absent, unpredictable, and unprofitable, and (4) Well nodulated soybeans add to rather than deplete soil nitrogen. In total the results show that applying nitrogen fertilizer to soybeans is unprofitable, thus a scarce resource (N fertilizer) can be conserved without reducing production by withholding it from soybean fertilization programs.

Stoneville, MS: (See T01) - This is a new program. The 1975 season was utilized for exploratory observations and organizing equipment.

Lafayette, IN: (T. S. Abney) - Fungicide investigations for control of late-season soybean diseases further corroborated preliminary studies indicating incidence of seed-borne fungi reduced on plants receiving foliar applications of benomyl, and aerial applications in 5-10 gal H₂O/a are as effective as small plot applications in 100 gal H₂O/a.

Urbana, IL: (J. E. Harper, R. L. Cooper) -

Nitrogen Relationships and Mineral Nutrition: The urea form of nitrogen does not directly inhibit infection of soybean root hairs by Rhizobium japonicum as does nitrate. Nodule development was extensive at levels of urea as high as 12mM N. In contrast, nitrate levels as low as 0.5 mM completely inhibited nodule formation. With ammonium nutrition, nodulation was intermediate to that with nitrate and urea nutrition. Nodule development under urea nutrition appears to occur due to the slow rates of urea uptake, relative to nitrate. It is proposed that the slow uptake rates of urea allow a high C:N ratio in the plant and hence adequate carbon is available for nodule development and function. Use of a nitrification inhibitor (N-serve) in conjunction with urea in field trials did not prevent interconversion of urea to nitrate and hence nodulation was inhibited by urea. Further testing of the compatibility of urea fertilizer with nodulation in the field will require development of methods to prevent urea conversion to nitrate. The optimum pH for soybean nodulation was established in solution culture using urea as the N source and controlling pH with a cation exchange resin. The optimum pH for nodulation was between 5.2 and 7.0. Below pH 5.0 and above pH 7.0, nitrogen fixation as estimated by acetylene reduction was decreased.

Cultural: Completed 3 years of cooperative research with Ralph Nave, Agricultural Engineer and Loyd Wax, Weed Scientist, which demonstrated the practicality of planting soybeans in 7-inch rows using commercially available grain drills and herbicides. This practice, because of the potential 10 to 20 percent yield increase over wider rows and the reduced cost of production by elimination of cultivation is gaining grower acceptance in the Midwest.

Columbia, MO: (M. R. Gebhardt and V. D. Luedders) -

Large-scale production study: This year was drier than usual with only 2.7 inches of rain from June 18 to August 24. This hot, dry summer caused the soybeans planted in June to outyield those planted in early May by 13 bu/A. The August rains came early enough to benefit the June planting but too late to help the May planting. During May, the pre- + post-emergence herbicides resulted in yields equal to those with the pre-emergence herbicides + cultivations. Yields in May did not differ with tillage practice or row width. However, in June, the yields were significantly less with the no-till practice. The post-emergence herbicides in June controlled most of the remaining weed species causing the yields to increase from 19 to 24 bu/A. Soybeans planted in June in a conventional seedbed with full weed control yielded 32 bu/A. Measurements of insect

infestations show more insects in 15- than in 30-inch rows. There were other large differences in insect specie populations due to interactions of some of the other cultural practices. Seven insect species were affected by tillage and eight species were affected by planting date. The weed control practice had an affect on six species of soybean insects. Predator populations were affected by all factors except herbicide application at V2 and tillage at R8 with many second- and third-order interactions. Orius insidiosus (Say) was most abundant and populations of Nabis and spiders were also found in May plantings. The seed quality from the June planting date and the no-till treatments were better than the May plantings and conventional tillage plots. Percent stand at the end of the season was greater for the June planting than for the May planting and greater in the 30-inch rows than in the 15-inch rows. Final stand at harvesttime varied from 50 to 70 percent of the number of seeds planted in the spring. Soil moisture percentages were determined gravimetrically on a weekly basis throughout the season. The surface values will be expressed on a percent-by-volume basis after the appropriate bulk density measurements are taken in 1976. The surface soil moisture percentage reached its maximum dryness by early July. The roots extracted moisture to a total depth of approximately 112cm by mid-August. The net income from conventional and no-till tillage systems was about the same, although, with the no-till system, there was a saving in time which would allow a farmer to farm more acres of land than with conventional tillage. Machinery investment per acre and ownership costs were constant for both no-till and conventional systems. Post-emergence weed control (either mechanical or chemical) was necessary for a profitable system. There was an indirect relationship between weed infestations and yields. Percent weed control was highest for the conventional June plantings with both pre- and post-emergence herbicides. Percent weed control was lowest with the no-till pre-emergence only and was intermediate with all other systems. Percent weed control in the cultivated plots was approximately equal to the plots with conventional tillage plus a pre- and a post-emergence herbicide treatment. Populations of the Macrophomina phaseolina (charcoal rot) in the soil remained constant throughout the summer with a decline during the winter due to freezing injury. Soybean plants infested with charcoal rot died earlier and yielded less than uninfested plants. The severity of charcoal rot in soybeans was directly related to the inoculum density in the soil, which in turn was related to the number of years the land was in corn and/or soybean production. Soybean mosaic and bean yellow mosaic were the two viruses recovered consistently from the soybean plants, although the frequency of their occurrence was low. Infected plants occurred at random throughout the plots with no correlation due to cultural practices.

Level II research studies: Detailed studies of soil moisture and energy budget were continued. Light use, leaf water potential and leaf stomatal behavior of the soybeans were measured under the narrow- and wide-row spacings. There were large and consistent differences in light utilization over the season, but no differences between the two row spacings. The stomatal activity of the lower shaded leaves was much less than of the upper leaves on the soybean plants. The dynamic characteristics of soil

moisture throughout the soil profile during the growing season was measured again this year. Soil moisture was again measured in soil where soybeans, corn, and meadow were growing at the Fleetwood and Kingdom City research sites. The results readily show the time and depths of soil moisture by the crops and the infiltration and redistribution of rainfall. These data will be used to estimate crop moisture stress and its relationship to crop yield. Small runoff-erosion plots at the Kingdom City research site were used to measure the soil loss, water runoff and chemical movement when several soybean production management practices were used. Runoff was greater from plots with no tillage than it was from plots with conventional tillage. Soil loss was greater from plots with conventional tillage practices. A study was initiated at the Delta Research Station for studying the populations and intensity of soybean cyst nematodes on soybean roots throughout the growing season. The concentration of nematodes decreased as the season progressed. The soybean cyst nematode reproduced three times during the growing season. Nodulation was reduced in the heavily infected roots.

Ames, IA: (J. M. Dunleavy, H. Tachibana) -

Disease Losses: Powdery mildew caused by Microsphaera diffusa occurred on soybeans in central Iowa in 1975. Fields (311) in 38 central Iowa counties were sampled. Powdery mildew infected 79 percent of the plants in 19 percent of the soybean fields examined. Disease reaction of 50 soybean cultivars of diverse genotypes, grown in the greenhouse and tested for infection, ranged from immune to very susceptible. Among cultivars currently in production, Beeson was resistant, and Amsoy, Corsoy, Hark, and Norman were susceptible. Powdery mildew was epiphytotic on susceptible cultivars in the field test from late July until plants matured. Mycelial development on leaf surfaces was dense and conidial production was profuse during this period. Three susceptible (S) and three resistant (R) cultivars were tested. One S and one R cultivar in maturity groups II (early), III (optimum), and IV (late), were tested as follows: Harosoy 63 (S) and Lindarin 63 (R), group II; Kanrich (S) and Wayne (R), group III, and Bonus (S) and Cutler 71 (R), group IV. Sprays containing benomyl at a concentration of 1 g 50 percent WP/liter were applied to certain plant rows until run off, at weekly intervals, from July 1 until plant maturity to furnish controls. The benomyl-sprayed, S cultivars, Harosoy 63, Kanrich, and Bonus, yielded 9, 14, and 9 percent more, respectively, than the same nonsprayed cultivars. The combined mean loss of these three cultivars, caused by powdery mildew, was 10.7 percent. A study of losses caused by pod and stem blight (Diaporthe phaseolorum var. sojae) was conducted in the field, but the exceptionally dry fall weather resulted in very low infection and no loss.

Brookings, SD: (C. B. Dybing) - Brookings was one of seven locations in a nationwide test of the effect of seed size and brassin treatment on yield of soybeans. Test arrangements were made and results will be summarized by USDA, ARS, Beltsville. No significant effect on yield was observed at Brookings.

Davis, CA: (B. H. Beard, J. M. Klisiewicz, A. L. Urie) - Vegetative and reproductive states were used to record plant development for 24 soybean varieties in plots with one plant in hills 1-foot apart and in regular yield test plots on 30-inch rows. Leaf length and width measurements were correlated with leaf area measurements to determine an easier method of determining leaf area per plant under different environmental conditions. The analyses are not completed.

Peanuts - T01

Suffolk, VA: (K. H. Garren and T. A. Coffelt) - In 1975, 73 advanced breeding lines were tested for improved yield potential and favored quality characters. Forty percent of these lines were higher yielding than the currently grown cultivars. One hundred lines were selected from early generation breeding lines for testing in 1976. Five cultivars and six commercial grades of each cultivar were analyzed for proximal and amino acid content of the meal. One (NC-FLA 14) was consistently higher in most of the components tested, whereas one (NC 17) was consistently lower. Peanuts in the extra large grade were significantly higher in most components, while peanuts in the oil stock grade were significantly lower. Eleven plant introductions, breeding lines, and cultivars were screened in the field for 2 years for resistance to the peanut pod breakdown fungi Pythium myriotylum and Rhizoctonia solani. Two lines had significantly less pod breakdown than the other nine. In a 1-year study five lines had less than 3 percent pod breakdown. Over 150 peanut plant introductions, breeding lines and cultivars were screened for resistance to Cylindrocladium black rot (CBR) caused by Calonectria crotalariae (Cylindrocladium crotalariae). About 10 percent of these lines have some resistance to CBR. In a 2-year study involving 12 Spanish cultivars, nine cultivars were not significantly more infected than Spancross, the best cultivar. Two cultivars were significantly more infected than any other Spanish lines. In a 2-year study of both Spanish and Virginia peanuts, seven additional lines were not significantly more infected than Spancross. In a 1-year study of six varieties no direct relation could be found between apparent degree of resistance to CBR and number of microsclerotia of CBR pathogen formed in the stem bases and roots of the variety. However, in a study of four varieties the CBR pathogen disappeared in 3 to 4 months in seed of a highly susceptible variety but was still present at 9 months in resistant varieties.

Tifton, GA: (R. O. Hammons and A. C. Mixon) - Twenty-two released or candidate cultivars, and two checks, from all U.S. breeding programs were arranged in two maturity groups and each grown in replicated trials under two water management systems (irrigation vs. natural rainfall at three locations: Tifton and Plains, Georgia, and Headland, Alabama) and harvested to evaluate yield, measure quality and estimate market value in these States. Published annual and cumulative performance data provide the basis for varietal release, extension recommendations and grower choice. Test yields in 1975 averaged 4566 vs. 4328 kg/ha at Tifton, 4401 vs. 4157 kg/ha at Plains, and 4933 vs. 5020 kg/ha at Headland for irrigated vs. rainfed management, respectively. Under all management systems across the three locations,

potential new cultivar 'UF 70115' edged 'Florigiant' 5215 to 5182 kg/ha (1.2%), and Florunner and 'Ga. Exp. 194R' were about equal (5509 vs. 5471 kg/ha). A record experimental yield for Alabama of 6662 kg/ha (2.97 t/a) was made with Exp. UF 714021 at Headland. Eight hectares of Ga. Exp. 194R were grown to study farmer acceptance, commercial milling outturn and end-use product suitability of this potential cultivar. Performance data were obtained for UF 70115 from cooperating engineering, herbicide and mineral nutrition investigations.

Laboratory screening of 1116 peanut seed samples for reaction to seed colonization by Aspergillus flavus (NRRL-2999) included 60 genotypes selected for resistance-tolerance in prior research, 21 genotypes selected from resistant x improved cultivars, 55 Valencias from New Mexico, and 24 commercial cultivars. This study is part of a continuing search for a commercially-acceptable A. flavus resistant cultivar. Under laboratory conditions highly favorable to the growth of A. flavus, seed colonization of resistant genotype PI 337394F was greater at 20 percent adusted seed moisture than at 15, 25, and 30 percent adjusted moisture, and colonization increased with each increase in storage time from 0 to 6 to 12 weeks and for each temperature increase from 5 to 20 to 35°C. Immature and over-mature seed of two resistant genotypes (PI 337394F and PI 337409) were more susceptible than sound-mature seed.

To shorten generation intervals 253 genotypes from Tifton were winter-increased at Mayaguez Institute of Tropical Agriculture, Puerto Rico. Included were F₁'s, select progenies from crosses studying the nature and incorporation of Aspergillus flavus resistance, newly introduced Valencias, the known world collection of rust- (Puccinia arachidis) resistant genotypes, and agronomic selections. In seed multiplication and spaced-plant nurseries at Tifton 341 bulked-plant rows and progeny plots were increased and selected, and seed was renewed for 96 other genotypes. Seed were distributed worldwide for two A. flavus resistant (PI's 337394F and 337409), three rust resistant (PI's 259747, 314817, 298115) and the very early-maturing 'Chico' peanuts. F₅ or F₆ progenies from 'Chico' x '5 cultivars' harvested at 100 days and mass selected, were winter-increased to give F₆ or F₇ populations for evaluation in 1976 of varietal possibility for relay (double) cropping.

Georgia and Alabama have recently become one-variety States with 94 percent and 99 percent of the peanut crop in one cultivar. This change predisposes the crop to loss by disease epidemic, insects, or environmental hazards. Multiline compositing of early generation sibs and objective mass selection (using the pod presizer) are among breeding procedures being used to increase genetic variability. Fifty-one new cross combinations were made to initiate new inheritance and breeding studies. An inverse relationship between the Arginine Maturity Index (AMI) value and fruit development and dry matter percentages was found for eight peanut cultivars in a study cooperative with a visiting Israeli scientist. Host plant response in terms of severity of galling indicated that all 512 genotypes sampled did not possess resistance to the root-knot nematode Meloidogyne arenaria, when inoculated at planting with about 1500 larvae per seed.

Stillwater, OK: (D. J. Banks) - Hybridization procedures to combine wild species of Arachis and cultivated peanut genomes in living systems carrying resistance or tolerance to leafspots and nematodes advanced. Fertility in sterile triploids and in sterile diploid hybrids was induced by ~~an~~ improved colchiploidy technique. Procedures utilizing thin layer chromatography to detect parentage of peanut hybrids were improved. Preliminary studies of cells in root tips and leaf tissue utilizing DNA specific fluorochromes showed potential for use in polyploid evaluations. Pollen counts were made on hybrids involving wild by wild and wild by cultivated peanut parents and revealed plants that can be used in further hybridization work. Preliminary studies utilizing a commercial small particle counter indicated that rapid pollen size analyses can be made and that they may reveal potential pollen viability and thus speed considerably these routines. Advanced field sections were made in peanut lines derived from hybridization that possess considerable resistance to defoliation in the presence of leafspot infection. Preliminary yield evaluations of advanced early maturing Spanish peanut lines derived from hybridization showed high yield potential.

Peanuts - T02

Suffolk, VA: (K. H. Garren, D. M. Porter, F. S. Wright) - The influence of tillage practices such as deep and shallow fall or spring plowing or spring chisel plowing, plant bed type and cultivation on the severity of Cylindrocladium black rot of peanuts, caused by C. crotalariae, was investigated. Significantly fewer plants were infected with C. crotalariae at harvest and yield and value were significantly greater in the deep-plowed fall treatment than in the other treatments. Infection was significantly less at harvest in peanuts planted on high beds than on medium or flat beds. Significantly fewer plants were infected and yield and value was greater in plots not cultivated than in cultivated plots. A field and laboratory study showed that viable microsclerotia of the CBR pathogen can be spread over considerable distances in fields by parts of tillage equipment that penetrate the soil. Microsclerotia on tillage equipment could not be shown to be viable after 15 minutes of air-drying in sunlight of the infested soil adhering to tillage equipment. Elevated levels of three plant nutrients were used on two varieties to determine the effect on the severity of CBR. No significant differences were observed between plots treated with high levels (2000 lbs/A) of calcium sulfate, magnesium sulfate or potassium sulfate and the untreated checks.

The severity of Southern stem rot, caused by Sclerotium rolfsii, was not influenced by plow treatment (fall or spring), depth of plowing (5" or 10"), or bed shape (flat or rotovated). However, significantly more disease occurred in cultivated plots than in non-cultivated plots. The growth rate of Sclerotinia sclerotiorum is greatly restricted on culture media amended with chlorothanlonil. However, sectors representing culture variants sometimes occur along the margin of colonies growing on amended media. These variants resemble in growth characteristics and Sclerotia production isolates growing on nonamended medium. Bed shape type, cultivation (early vs. late)

and chiseling under the row 18 inches at planting did not affect the incidence of pod breakdown. The addition of land-plaster and peanut seed size did not affect the incidence of pod breakdown. Higher incidences of pod breakdown were sometimes noted in plots receiving elevated rates of insecticides. Cooperative (with VPI&SU and NASA) remote sensing studies on detecting and estimating CBR and Sclerotinia blight were initiated in 1975. Ten peanut cultivars and breeding lines were grown under optimum and low fertility conditions for 2 years. While significant differences between yields and values/acre have been observed, analysis of plant tissue samples for nutrient content has not been completed.

College Station, TX: (D. L. Ketring) -

Controlled Environment Studies: Treatment of 'Starr' peanuts with high relative humidity (>80%) during the last hours of dark in a 12-hr light/12-hr dark cycle was completed. Two experiments (3 replications of 16 plants per experiment) were completed for 0, 3, and 6 hr of high relative humidity.

Greenhouse Growth Regulator Treatments: Four different plant growth regulators were applied to Starr peanuts to test for their effects on growth, flowering, and fruiting. A manuscript has been submitted to Agronomy Journal.

Seed Germination Tests: Further experiments concerning the opposite effects of abscisic acid and ethylene on germination, growth and enzyme activities of dormant 'NC-13' and non-dormant 'Starr' peanut seeds were done. The effects of various salts and growth retardants on germination of dormant NC-13 peanuts were tested in relation to breaking dormancy by ethylene treatment.

Efficient Water Utilization by Peanuts: Two varieties of peanuts, 'Tamnut 74' and 'Florunner,' grown under rainshelters in the field were given a 21-day stress period beginning at 15, 30, or 45 days after emergence. The stress period beginning at 30 days after emergence significantly reduced yield of both varieties.

Flax - T01

Brookings, SD: (C. B. Dybing) - Techniques were developed for in vitro measurement of transport of C¹⁴ in flax panicle segments. Upward movement of sucrose into fruits was detected in 6 to 8 hr for flax. IAA applied to the first flower or fruit of soybean was moved both upward and downward. IAA moved downward from flax fruits slowly, apparently because of penetration difficulties. Tissue culture tests failed to clearly demonstrate correlative effects of developing flax fruits on inhibited panicle buds at nodes immediately above and below the fruit node. Explants with intact bolls grew slowly and senesced rapidly. Excision of the boll delayed senescence and permitted shoot development at both inhibited bud sites. Even greater activity occurred with explants having an aborted fruit at the fruiting node. Long term studies of flax lines from the world collections were

continued and data for the entire study were summarized. Pairs of lines were identified which are similar in agronomic type, morphology, disease reaction, flowering date, and maturity but markedly and consistently different in yield. Relationships between yield and various measured traits were inconsistent from year to year. Characteristics expressing degree of branchiness or quantity and arrangement of foliage were poorly related to yield in most years. Seed and boll sizes were identified as major yield factors for early lines in 1973, as were seeds or bolls/area and seeds/boll for late lines. Rapid panicle development was important for yield in 1974 and 1975. For early lines, bolls/plant was positively associated with yield in both years, and total foliage (% dry wt) was important for late lines. NCE rates tended to be associated with yield in the same manner as total foliage. NCE rates of plants with only panicle foliage were no better associated with yield than rates for whole plants.

Fargo, ND: (D. E. Zimmer, D. C. Zimmerman, J. F. Miller) - A gas chromatographic procedure was developed for the detection of 12-oxo-trans-10-dodecenoic acid (12-CHO) in seedling extracts. With this procedure and mass spectrometry, we have identified endogenous 12-CHO in flax, sunflower, and soybean seedlings. 12-CHO was present in both free acid and esterified forms. Hydroperoxide lyase enzyme, which forms 12-CHO from linoleic acid hydroperoxide, was found in all of the tissues tested. We believe 12-CHO is a precursor to traumatic acid which was identified as a wound hormone in beans. We tested beans and found no traumatic acid but large amounts of 12-CHO instead. We believe that 12-CHO may be the actual wound hormone and may have a growth-regulating function during normal growth and development. Graft transfer of cytoplasmic male-sterility in flax was studied by reciprocally grafting normal scions on CMS stocks and grafting CMS scions on normal stocks. Graft transfer of CMS did not occur and cannot be considered a possible tool in flax breeding. Approximately 1500 flax genotypes selected from the world collection were crossed with a cytoplasmic male-sterile line to screen for open-flowered characteristics. None of the world collection genotypes were open-flowered and male sterile in the F_1 generation. Selection of plants with stable male-sterility is hindered as a relationship exists between age of the plant and increasing fertility in many of the original sources of male sterility. Marker genes and cytological examination were used concurrently to determine the origin of haploid cells in cultivated flax genotypes. Haploid cells which produce the haploid flax seedlings appear to be maternal in origin. Evaluation of a haploid breeding method has been initiated. Breeding lines which contain at least two rust genes, each conditioning resistance to all North American races of flax rust, have been advanced through the F_2 generation. Lines with the following gene combinations will be selected from progeny of this material: M^3P^3 , L^6M^6 , L^6P^4 , $L^{11}M^3$, $L^{11}M^6$, $L^{11}P^4$, M^6P^3 , and M^6P^4 .

None of the six new races of flax rust identified in 1975 from 87 field collections of urediospores studied constitute a threat to the present recommended flax varieties. All of the new races combine virulence and avirulence genes known to exist in North America. Breeding lines containing two or more genes for rust resistance, each gene conditioning resistance

to all North American flax rust races, were identified. Over 3000 rows of F_5 lines identified as homozygous for both rust resistance genes M^3 and P^3 are being evaluated for agronomic acceptability. Genetic analysis and pathogenicity tests with flax rust races of known virulence established that the variety 'Foster' contains the L^6 and M genes for rust resistance and that 'Dufferin,' an introduced variety from Canada, contains the linked N^1P genes plus an undescribed dominant gene conditioning resistance to all known North American races. The rust resistances of six Argentinian flax introductions were found to be conditioned by two or three known genes which collectively but not individually condition resistance to all North American races. One-year data from a 2-year study suggest that field rust resistance discovered for the first time in the flax variety 'Nored' may be sufficient to avoid losses from the present native races of flax rust.

Flax - T02

Brookings, SD: (C. B. Dybing) - Twenty-five chemicals representing several types of plant growth regulator were applied at seedling, early bloom, and post-bloom stages to modify flax performance in the field. Dosages were kept low to minimize detrimental abnormalities and toxicity. The flowering period was shortened by early July drought, and no growth regulator significantly increased yield. Most treatments applied at vegetative stage decreased yield. Application of cytokinin delayed senescence approximately 1 week. Combination treatments applied post-bloom containing both cytokinin and antiauxin appeared most promising for yield enhancement. Ethylene stimulating chemicals, inhibitors, hormones other than cytokinin, fungicides, and other chemicals produced many specific growth effects, but all had little effect on or even reduced yield. Variety-by-regulator effects for yield were non-significant. Plant height, primary branching, and seeds/boll, were decreased by various chemical treatments. Whereas panicle width, basal branching, and secondary branching were not affected. Seed weight (mg/1000 seeds) was monitored for all flaxseed samples obtained from field growth regular trials in FY 76. Ethrel and N-1-naphthylphthalamic acid reduced seed weight when applied to flax in the vegetative stage. This appeared to be due to reduced seedling vigor and flowering delay. No effect was observed following treatment of flax with beta-hydroxyethyl hydrazine, a chemical which has increased seed weight in past years.

Sunflowers - T01

Beltsville, MD: (C. A. Thomas) - A *Verticillium* isolate from infected sunflowers at Lubbock, Texas, was virulent to several cultivars that are highly resistant in North Dakota. The isolate appears to be a cotton defoliating strain of *V. dahliae*. Mild cotton strains of *V. dahliae* were very weakly virulent or avirulent. *Phytophthora drechsleri* was weakly to moderately virulent to sunflower stems and avirulent to roots. *P. cryptogea* and *P. citricola* were avirulent to both stems and roots.

Fargo, ND: (D. E. Zimmer, D. C. Zimmerman, G. N. Fick, T. E. Thompson, J. F. Miller) - The best hybrid sunflowers produced by cytoplasmic male-sterility and genetic fertility restoration exceeded yields of the standard

open-pollinated varieties by more than 30 percent. Calculation of stability parameters of selected hybrids and varieties indicated that certain hybrids were widely adapted, and that yield stability was not necessarily dependent on the greater genetic heterogeneity of open-pollinated varieties. An oilseed inbred line HA 291, and two large-seeded sunflower confection inbred lines, HA 292 and RHA 293, were released. RHA 293 is expected to have widespread use since it is the first large-seeded fertility restorer line with resistance to downy mildew. Parental lines released previously are now used to produce most of the hybrid seed for commercial planting in the U.S. Heritability and recurrent selection studies in sunflowers for oil content and seed size indicated that significant progress for high oil content and seed size can be realized by selection in early generations. Genetic studies indicated that the possible new source of cytoplasmic male sterility reported by French researchers in 1974 is likely not different from the male-sterile source used currently. Monogenic or digenic inheritance was indicated for several floral color and morphological variations suitable as genetic markers in hybridization studies.

Four chemical spray treatments were evaluated for their desiccating action on sunflowers. Paraquat ($\frac{1}{2}$ lb/A) and Desiccate (2 lbs/A) appeared to be effective treatments but reliable moisture data could not be obtained because birds ate the drier seeds. The use of electronic moisture meters for sunflowers was thoroughly investigated. Reports of erroneous moisture content by elevator operators were shown to be due to inadequate equilibration of sunflower seed before testing. Procedures were recommended for proper calibration and use of electronic moisture meters. A method was discovered for the differentiation of pigmentation in the outer three layers of confectionery sunflower seeds. Treatment with 1 percent sodium hypochlorite for 30 minutes yielded seeds which could be classified on the basis of color. One attempt was made to correlate color classification with insect damage. The results were negative but the overall level of damage was less than 5 percent. The test offers potential as a selection tool for certain characters in the breeding program, since it is non-destructive. Sunflower seed harvested at 28 and 56 days after flowering had markedly different contents of abscisic acid, 215 to 70 ng/g dry wt. The levels of abscisic acid in the seed may be directly related to dormancy in sunflowers. Samples of hybrid oil-type sunflowers which contain small amounts of striped seed were examined and found to contain 2 to 2½ percent less oil than the all-black seeds from the same variety.

Approximately 3200 samples of sunflower and flax were examined for oil content by NMR. The data was used by geneticists and pathologists in their research programs. Collection, cataloging, and evaluation of 10 wild species of sunflowers have been initiated. Fall planting has been successful in breaking seed dormancy in some species. Proper methods to maintain these species are being evaluated. Genetic analysis established that N 13-11-1, a sunflower line from Yugoslavia, contains a dominant gene(s) for rust resistance different than those of RHA 266. The downy mildew resistance of N 13-11-1 and that of the French line HIR-34 was not demonstrated to be genetically different than that of HA 61, the original source of the Pl₂

gene. Through coordinated greenhouse and field testing, sunflower lines were identified that contain genes for recessive branching, fertility restoration, and dominant resistance to rust, *Verticillium* wilt, and downy mildew. Sunflowers were demonstrated to be more susceptible to *Sclerotinia sclerotiorum* over a longer period of time than dry beans. The basal stem phase of *Sclerotinia* wilt of sunflower was not as dependent upon climatic factors as was the head rot phase.

Vernon, TX: (R. E. Stafford, C. E. Rogers) - Two sunflower cultivars were evaluated at 8 planting dates at Chillicothe, Texas. Early March and mid-season plantings gave the highest seed yields. Test weight and oil content were generally highest in the early planted tests. Oil content decreased 11 percent as planting dates were advanced from March 3 to June 26. Preliminary observations suggest that early planted sunflowers withstand insect pests more readily than later plantings. Twenty commercial sunflower hybrids, 263 experimental hybrids, and 36 parental lines were screened for resistance to the carrot beetle. Carrot beetle infestations were light; percent reduction in stand due to carrot beetle injury averaged 2.6 percent. No significant differential response to the carrot beetle was observed within the germplasm evaluated. Regional sunflower variety trials were coordinated for 16 locations in the Oklahoma-Texas area. Yields in the regional variety trial at Chillicothe ranged from 504 lb/A (Sun Hi 301) to 989 lb/A (Sunbred 212). Oil content of the 11 entries ranged from 39.6 to 47.4 percent.

Two species of longhorned beetles (*Mecas inornata* and *Ataxia hubbardi*) girdled up to 24 percent of the sunflower plants in some parts of the Texas Rolling Plains. These species have been established in the laboratory and the bionomics of each is under investigation. A laboratory colony of the sunflower beetle (*Zygogramma exclamatoris*) has been established and bionomic studies are underway. The biology of a lacebug (*Corythucha morrilli*) on sunflower was determined. Field development of the carrot beetle (*Bothynus gibbosus*) required 87 to 107 days, with all adults of the new generation emerging prior to July 15. The nocturnal flights of adults occur primarily prior to 10:30 p.m. A dozen of the 162 synthetic organic chemical compounds tested for attractancy toward the carrot beetle showed promise and need further evaluation. A definite correlation was shown between Rhizopus head rot and infestation by the larva of the sunflower moth (*Homoeosoma electellum*). Several species of parasitoids were reared from the sunflower moth. Two seed types among 10 lines of sunflower tested for resistance to the sunflower moth showed significantly less damage than the seed of variety Peredovik-66. Date of planting had a definite influence on the intensity of injury caused to sunflower by the above species, as well as for several other species of potential sunflower pests.

Bushland, TX: (B. A. Stewart, C. E. Rogers, T. E. Thompson) - The effects of date of planting on two sunflower cultivars (Sun-Gro 372 and Peredovik-66) were evaluated at Chillicothe, Texas. The March 3 and June 9 dates of planting resulted in the highest yields. Test weight and oil content were highest in the earliest planted tests. Oil content decreased by 11 percent (46.2 to 34.9 percent) as the dates of planting advanced from March 3 to June 26.

Early plantings were not damaged by a temperature in the low 20's during March and early April. The National Sunflower Performance Test comprised of nine hybrids and two open-pollinated varieties evaluated at Chillicothe, Munday, and Iowa Park, Texas. Although performance varied among entries depending on date of planting, location, and management practice, hybrid Sunbred 212 ranked first in yield at all locations. The yield averaged 738 and 1189 pounds of seed per acre for dryland and irrigated tests, respectively. Oil content of seed ranged from 39.6 percent in Sun-Hi 301 to 47.7 percent in Sunbred 212 in the Chillicothe test that was not treated for insect control.

Weekly surveys in a date of planting test indicated that major pests of sunflower in the Rolling Plains of Texas were: (1) carrot beetle, Bothynus gibbosus; (2) sunflower moth, Homoeosoma ellectellum; (3) cerambycids, Mecas inornata and Ataxia hubbardi. Secondary pests included the moth Suleima helianthana, sunflower beetle, stem weevils, seed weevils, midges, head clipper, and miscellaneous defoliators. Nocturnal flights of the carrot beetle were found to occur primarily prior to 10:30 p.m. None of the 162 synthetic organic compounds screened showed significant attracting toward the carrot beetle. The most effective attractant was a hot water extract of sunflower roots. Field development of the carrot beetle required from 87 to 107 days, with adults emerging prior to July 15. There was a significant correlation between Rhizopus head rot and infestation by larvae of the sunflower moth. The biology of cerambycids girdling sunflower was studied in the field and in the laboratory.

Davis, CA: (B. H. Beard, J. M. Klisiewicz, A. L. Urie) - Plant height and number of leaves at 14, 28, 42, 56, and 70 days, stem diameter at 42 days and maturity, leaf length and width at 42 days as influenced by 36 different environments are available for correlation with yield, oil content and fatty acid components of the oil. Preliminary statistical analysis indicates stem diameter and yield are associated but predictive value is only about .4. The backcrossing program to produce isogenic lines was continued. Sunflower moth populations were very low and our resistant inbreds and hybrids were not tested adequately. Material was available to determine chemicals that are associated with host plant resistance in cooperative studies with WRRRC. Half seed analyses indicated some wild Helianthus species crosses with a genetic male sterile domestic line (P-21) had 60 to 70 percent oleic acid in the seed oil. Plants from these seeds were used in about 1000 self, sib, and backcross pollinations. Phytophthora cryptogea was identified as the organism causing stem rot of sunflowers. Roots of sunflower are resistant whereas the hypocotyl and stem are susceptible.

Sunflowers - T02

Davis, CA: (B. H. Beard, J. M. Klisiewicz, A. L. Urie) - A 2-year study of the effects of date of planting and population density was completed. Maximum yields were obtained from plots which were seeded during May. Seed yields were slightly lower from seeding in April but much lower if seeding was in June or July. These data indicate that the optimum time to plant sunflowers is from May 1 to 20 and the present hybrids or varieties would not be suitable for a second crop following small grains. Plant spacing in rows 30 inches apart had very little effect on seed yields. A stand that varied from 6 inches to 18 inches between plants in the row should not be replanted. The hybrids P01 304 and HS52 were similar in response to the variety 'Peredovik' but the hybrids produced slightly higher yields. The variety 'Tcherianka' was different in many characteristics. The variety Peredovik was planted on May 15 in plots with different applications of applied fertilizer. The eight treatments consisted of a check, 80 lbs of nitrogen, 50 lbs of phosphorus, 100 lbs of potash and all possible combinations of these three elements plus 120 nitrogen with 50 lbs of phosphorous and 100 lbs of potash. Yields were not significantly different from the check plot with any of the treatments.

Safflowers - T01

Beltsville, MD: (C. A. Thomas) - Breeding lines resistant to both the mild and the defoliating cotton strains of Verticillium dahliae were obtained from selections of P.I. 253528. Selfed progenies of individual plants resistant to the mild strain were screened for resistance to the defoliating strain. Breeding lines with adult plant resistance to race 2 of Fusarium oxysporum f. sp. carthami were obtained from several cultivars that are homozygous for susceptibility in the young seedling stage. One cultivar, 'Pacific 2,' was homozygous susceptible in the adult stage but resistant in the young seedling stage. The observations indicate that seedling and adult plant reactions are conditioned by different genes. Breeding lines resistant to lettuce mosaic were obtained from the cultivar 'B3.' A high percentage of the plants of the lines showed neither mosaic nor necrosis symptoms.

Tucson, AZ: (L. H. Zimmerman) - Safflower genotypes responded differently to humidity stress applied to their pollen in situ. Heads with pollen-free stigmas of BC10 thin-hull 'Gila' pollinated with pollen from Gila plants exposed to high humidity for 24 hours before pollination produced 44 percent less seed than those exposed to low humidity; whereas similar stress applied to N4051 pollen resulted in 28 percent less seed. There was also a genotype difference when the stress was applied for 24 hours after pollination. High-humidity stress reduced set 28 percent with Gila pollen and 2 percent with N4051. The female gametes were also sensitive to humidity stress. Seed set was reduced 15 percent when female heads were exposed to high humidity for 24 hours before pollination. A study of population structure in BC₂ for

seed dormancy, a polygenic trait from a wild species by mass backcrossing and mass selection, showed useful variation. A bulk of lines selected for no germination the first 24 hours had significantly less germination than their base population, 2 and 10 percent, respectively, but within 72 hours had similar germination, 75 to 80 percent. The commercial recurrent parent had 53 and 80 percent within 24 and 72 hours. These selections should afford protection from preharvest rains and their harvested seed still germinate soon enough to obtain a stand when planted. Genetic variation for tolerance to flood-irrigation stress was shown in safflower germplasm. After flooding stress for 24 hours in 1974 and about 48 hours in 1975, mean survival of 16 lines from VFstp-1 was 67 percent (range 35 to 97) in 1974 and 5 percent (range 0 to 24) in 1975. Rank correlation of lines was highly significant. Survival of checks, N-10 and Gila, was 31 and 24 percent in 1974 and about 1 percent in 1975.

Davis, CA: (B. H. Beard, J. M. Klisiewicz, A. L. Urie) - Oleic Leed produced 19.2 percent more oil per acre than UCI or Gila under irrigated row culture. Under stress conditions (dryland or drill-seeded) the seed yields were lower but not significantly less than UCI. However, oil percentage of Oleic Leed was higher than UCI even under stress conditions. A new character termed partial hull is easily identified by a partially white-partially dark appearance of the seed. F_2 data suggest that partial hull is due to a recessive gene inherited independently from thin hull, striped hull, or high oleic acid. In yield tests, partial hull oleic had reduced seed yield high oil percentage of the seed (49.0%) but slightly less oil per acre than normal safflower. Selection 14-5 with *Verticillium* resistance, *Fusarium* resistance and striped hull had the most surviving plants in a root rot test at Yuma, Arizona. This same selection also had the highest survival in root rot test at Yuma, Arizona and Davis, California, in 1974. Selection 14-5 has been crossed to partial hull, oleic selections to combine multiple disease resistance with high oil, partial hull, and high oleic acid oil. Sixty-eight rust immune, *Verticillium* resistant, *Fusarium* resistant selections were made but oil percentages were low (mean = 36.3 percent, range 33 to 40 percent).

Fusarium race 4 resistant plants were selected from 15 introductions in greenhouse tests. In subsequent tests resistance of selected progenies was improved over the original non-selected populations. Eighteen plant introductions were found to be susceptible to systemic necrosis caused by lettuce mosaic virus, 12 were resistant to necrosis but developed systemic mosaic, and eight were mixed for both reactions. *Phytophthora drechsleri* has been known as the causal organism of root and stem rot of safflower. New species *P. cryptogea* and *P. parasitic* were identified and *P. cryptogea* strains were found that cause stem rot on safflower formerly considered stem and root rot resistant. In cooperation with WRRRC, 11 polyacetylenic compounds were identified from ether washings of safflower seedlings. The compounds stimulate germination of safflower rust teliospores - some more

actively at lower levels than others in assays. Both rust resistant and susceptible safflower possess such compounds. Rhizopus, Alternaria, Stemphylium, and Botrytis recovered from mature safflower seed heads appear to be associated with rotting of the receptacle, lowered seed set and reduced seed weight, seed discoloration, and an increase of free fatty acids in the oil.

Safflowers - T02

Davis, CA: (C. H. Beard, J. M. Klisiewicz, A. L. Urie) - Oleic Leed and UCI were subjected to four irrigation regimes. Under stress conditions UCI produced more seed per acre and more oil per acre than Oleic Leed. With adequate water UCI still produced more seed but less oil per acre than Oleic Leed. Oleic Leed had a higher oil content than UCI in all situations. The incidence of seedling rust was reduced from 9.8 percent in non-flooded field plots flooded for 7 days after harvest. This difference is statistically significant. Seed treatment with fungicides Vitabax or Dithane reduced the percentage of rusted seedlings in the field, however, complete protection was not provided.

Guar - T01

Vernon, TX: (R. E. Stafford, C. E. Rogers) - Experimental guar strains and varieties were yield-tested at 10 locations in the Oklahoma-Texas area. Yields ranged from 429 to 1898 lb/A in the harvested tests. New guar varieties, 'Kinman' and 'Esser,' yielded 11 and 9 percent more than 'Brooks,' respectively, in nine tests where all varieties could be compared. Kinman and Esser, released in 1974 by the USDA-ARS and the Texas and Oklahoma Agricultural Experiment Stations, are high yielding, possess tolerance to the major guar diseases, and have good regional adaptation. Forty experimental guar strains were evaluated in preliminary yield trials at Chillicothe, Texas. Approximately 1200 guar breeding lines were evaluated in a bacterial blight disease-nursery. Progeny from crosses of branching, bacterial blight resistant parents with a nonbranching, blight susceptible parent indicate that blight resistance has been successfully transferred to the nonbranching genotypes.

Bushland, TX: (C. E. Rogers) - Economic injury levels for midge (Contarinia texana) larvae attacking guar buds were established. Also, 182 guar plant introductions were screened in the field for resistance to the midge.

Publications

Soybeans

Beltsville, MD:

BOONKERD, NANTAKORN, D. F. WEBER, AND D. F. BEZDICEK. Influence of Rhizobium japonicum strains and inoculation methods on soybeans grown in Rhizobia populated soil. Agron. J. (In Press). (1976).

DEVINE, T. E. Genetic control of specificity of infection in host cultivar x Rhizobium strain interactions. Proceedings of the Fifth American Rhizobium Conference, Raleigh, N. C. p. 21. (1975).

DEVINE, T. E. Genetic studies of soybean host cultivar interactions with Rhizobium strains. Soybean Genetics Newsletter 3:19-20. (1976).

LEFFEL, R. C. AND B. E. CALDWELL. Effectiveness of three cycles of intercrossing and selection for seed yield within a diallel cross in soybeans. (Abstract). World Soybean Research Conference, University of Illinois at Urbana-Champaign, Urbana, Illinois, August 3-8. (1975).

LEFFEL, R. C. The Middle Atlantic States Uniform Preliminary Soybean Tests. PPHI Research Report No. 9. (1976).

LEGG, J. O. AND C. SLOGER. A tracer method for determining symbiotic nitrogen fixation in field studies. In: Proceedings of the Second International Conference on Stable Isotopes. Chicago, Illinois. (October 1975).

ORELLANA, R. C. AND J. F. WORLEY. Nuclear degeneration of root-nodule cells of soybeans grown in the presence of Rhizoctonia solani. World Soybean Conference, University of Illinois at Urbana-Champaign, Urbana, Illinois, August 3-8. (1975).

ORELLANA, R. G., C. SLOGER, AND V. L. MILLER. Rhizoctonia-Rhizobium interactions in relation to yield parameters of the soybean. Phytopathology 66:464-467. (1976)

PLASKOWITZ, J. S. AND T. E. DEVINE. Vegetative propagation of soybeans. Soybean Genetics Newsletter 3:21. (1976).

REBOIS, R. V., JULIUS FELDMESSER, AND ROBERT C. LEFFEL. Effects of three nematicides on nematode populations and soybean (Glycine max L. Merr.) yields in two Maryland fields. (Abstract). Annual Meeting Potomac Division, American Phytopathological Society, Newark, Delaware, March 17-19. (1976).

SLOGER, C. Biochemistry of N₂ fixation. In: Proceedings of the First World Soybean Research Conference, University of Illinois at Urbana-Champaign, Urbana, Illinois, August 3-8. (1975)

SLOGER, C. Associative nitrogen fixation in corn. (Abstract). Plant Physiol. 57:102. (Suppl.). (1976).

Raleigh, NC:

BRIM, C. A. Male sterility in recurrent selection. World Soybean Research Conference, University of Illinois at Urbana-Champaign, Urbana, Illinois, August 3-8. (1975)

KENWORTHY, W. J. A recurrent selection program for increasing seed yield in soybeans. (Ph. D. thesis under the direction of C. A. Brim). (1976).

RINNE, R. W., S. GIBBONS, J. BRADLEY, R. SEIF, AND C. A. BRIM. Soybean protein and oil percentages determined by infrared analysis. USDA Publ. ARS-NC-26. July. (1975).

ROSS, J. P. A new recognized strain of soybean mosaic virus. Plant Dis. Reptr. 59:806-808. (1975).

ROSS, J. P. Effect of overhead irrigation and benomyl sprays on late-season foliar diseases, seed infection, and yields of soybeans. Plant Dis. Reptr. 59:809-813. (1975).

TESTER, C. F. Control of the formation of isocitrate lyase in soybean cotyledons. Plant Science Letters 6:325-333. (1976).

TESTER, C. F. Characterization of the aminoacylation of cytoplasmic transfer ribonucleic acids for germinating soybeans. Physiol. Plant. 36: 242-246. (1976).

WILSON, R. F., R. W. RINNE, AND C. A. BRIM. Alteration of soybean oil composition by selection for high oleic acid. Plant Physiology Supplement 57:47. (Abstract). (1976).

Gainesville, FL:

HINSON, KUELL. Nodulation responses from nitrogen applied to soybean half-root systems. Agron. J. 67:799-804. (1975).

HINSON, KUELL. Nitrogen fertilization of soybeans (Glycine max L. Merr.) in Peninsular Florida. Soil and Crop Sci. Soc. of Florida Proc. 34:97-101. (1975).

SCHRODER, V. N. AND K. HINSON. Soil nitrogen from soybeans (Glycine max L. Merr.). Soil and Crop Sci. Soc. of Florida Proc. 34:101-103. (1975).

Stoneville, MS:

BARRENTINE, W. L., C. J. EDWARDS, JR., AND E. E. HARTWIG. Screening of soybeans for tolerance to Metribuzin. Agron. Jour. 68:351-353. (1976).

EDWARDS, C. J., JR., W. L. BARRENTINE, AND T. C. KILEN. Inheritance of sensitivity to Metribuzin in soybeans. Crop Science 16:119-120. (1976).

HATCHETT, J. H., G. L. BELAND, AND E. E. HARTWIG. Leaf-feeding resistance to Bollworm and Tobacco Budworm in three soybean plant introductions. Crop Sci. 16:277-280. (1976).

HEATHERLY, L. G. AND W. J. RUSSELL. Water relations and growth of soybeans (Glycine max L. Merr.) in drying soil. So. Branch Amer. Soc. of Agron. 3:8. (1976).

HEATHERLY, L. G., W. J. RUSSELL, AND T. M. HINCKLEY. Water relations and growth of soybeans (Glycine max L. Merr.) in drying soil. Crop Sci. (In review). (1976).

KILEN, T. C. An unusual miniature soybean. Crop Sci. 15:871-872. (1975).

KILEN, T. C. AND E. E. HARTWIG. Short internode character in soybeans and its inheritance. Crop Sci. 15:878. (1975).

RUSSELL, W. J. AND D. R. JOHNSON. Residual soil nitrogen effects on soybeans. Agron. J. (In review). (1976).

RUSSELL, W. J., D. D. RANDALL, AND D. R. JOHNSON. Nitrate reduction in soybean nodules and its potential contribution to nitrogen metabolism. Plant Physiol. (In preparation). (1976).

RUSSELL, W. J., D. R. JOHNSON, AND D. D. RANDALL. Nitrate reduction in soybean nodules and leaves in relation to N_2 (C_2H_a) fixation. Crop Sci. (In review). (1976).

Lafayette, IN:

ABNEY, T. S., T. L. RICHARDS, AND K. W. ROY. Effect of benomyl foliar applications on purple seed stain of soybeans. 1975 Amer. Phytopath. Soc. Absts. (1975).

ABNEY, T. S., J. O. SILLINGS, T. L. RICHARDS, AND D. B. BROERSMA. Aphids and other insects as vectors of soybean mosaic virus. Jour. Econ. Ent. 69:254-256. (1976).

ABNEY, T. S. AND V. D. LUEDDERS. Influence of temperature on deterioration of soybean seed quality. 1976 Amer. Phytopath. Soc. Absts. (In Press). (1976).

LAVIOLETTE, F. A., K. L. ATHOW, T. S. ABNEY, J. R. WILCOX, AND T. L. RICHARDS. Indiana soybean disease and crop condition survey 1975. Purdue Univ. Agric. Expt. Sta. Bull. No. 99, 6 pp. (1975).

PASCHAL, E. H., II AND J. R. WILCOX. Heterosis and combining ability in exotic soybean germplasm. Crop Sci. 15:344-349. (1975).

ROY, K. W. AND T. S. ABNEY. Fungal colonization of soybean pods and seeds. 1975 Amer. Phytopath. Soc. Absts. (1975).

- ROY, K. W. AND T. S. ABNEY. Purple seed stain of soybeans. (In Press). Phytopathology. (1976).
- ROY, K. W., T. S. ABNEY, AND D. M. HUBER. Isolation of *Gaeumannomyces graminis* var. *graminis* from soybeans in the midwest. 1976 Amer. Phytopath. Soc. Absts. (In Press). (1976).
- WILCOX, J. R., K. L. ATHOW, R. J. MARTIN, F. A. LAVIOLETTE, T. S. ABNEY AND T. L. RICHARDS. Woodworth soybeans in Indiana. Purdue Univ. AES. Stat. Bull. No. 68. (1975).
- WILCOX, J. R., F. A. LAVIOLETTE, AND R. J. MARTIN. Heritability of purple seed stain resistance in soybeans. Crop Sci. 15:525-526. (1975).
- Urbana, IL:
- BOERMA, H. R. AND R. L. COOPER. Multiple allele for male sterility in soybeans. Agron. Absts., p. 47. (1975).
- BOERMA, H. R. AND R. L. COOPER. Comparison of three selection procedures for yield in soybeans. Crop Sci. 15:225-229. (1975).
- BOERMA, H. R. AND R. L. COOPER. Performance of pure lines obtained from superior yielding heterogeneous lines in soybeans. Crop Sci. 15:300-302. (1975).
- BOERMA, H. R. AND R. L. COOPER. Effectiveness of early generation yield selection of heterogeneous lines in soybeans. Crop Sci. 15:313-315. (1975).
- BOWES, G., W. L. OGREN, AND R. H. HAGEMAN. pH dependence of the $K_m(\text{CO}_2)$ of ribulose 1,5-diphosphate carboxylase. Plant Physiol. 56:630-633. (1975).
- CHOLLET, R. AND W. L. OGREN. Regulation of photorespiration in C_3 and C_4 species. Bot. Rev. 41:137-170. (1975).
- COOPER, R. L. Morphological differences between semidwarf and normal soybean varieties. Agronomy Absts., p. 50. (1975).
- COOPER, R. L. Modifying morphological and physiological characteristics of soybeans to maximize yields. Proceedings First World Soybean Research Conference, University of Illinois at Urbana-Champaign, Urbana, Illinois, August 3-8. (1975).
- COOPER, R. L. Response of soybeans to ultranarrow rows and planting rates. Agron. J. (In Press). (1976).
- HARPER, J. E. AND J. T. VIGUE. Nitrogen metabolism in soybeans (*Glycine max.* L. Merr.) as affected by CO_2 enrichment. Agronomy Absts, p. 71. (August 1975).

HARPER, J. E. AND J. T. VIGUE. Nitrogen metabolism in soybeans (Glycine max L. Merr.) as affected by CO₂ enrichment. Agronomy Absts., p. 71 (August 1975).

LAING, W. A., W. L. OGREN, AND R. H. HAGEMAN. Bicarbonate stabilization of ribulose 1,5-diphosphate carboxylase. Biochemistry 19:2269-2275. (1975).

NICHOLAS, J. AND J. E. HARPER. Control of nutrient solution pH with an ion exchange system: Effect on soybean nodulation. Agronomy Absts., p. 74. (August 1975).

NISSLY, C. R., R. L. BERNARD, AND C. N. HITTLE. Day length sensitivity studies with maturity group III soybean germplasm. Soybean Genetics Newsletter 2:14-15. (1975).

NISSLY, C. R., R. L. BERNARD, AND C. N. HITTLE. Inheritance in chlorophyll deficient mutants. Soybean Genetics Newsletter 3:31-34. (1976).

OGREN, W. L. Control of photorespiration in soybean and maize. In: Environmental and Biological Control of Photosynthesis. R. Marcelle, (Ed.) N. Junk, The Hague. pp. 45-52. (1975).

RINNE, R. W., S. G. GIBBONS, J. BRADLEY, R. SEIF, AND C. A. BRIM. Soybean protein and oil percentages determined by infrared analysis, ARS-NC. Agricultural Research Service, U.S. Department of Agriculture. (1975).

SERVAITES, J. C. AND W. L. OGREN. Oxygen effects on photosynthesis in soybean mesophyll cells. Plant Physiol. 56:26. (Suppl.). (1975).

VIGUE, J. T., J. E. HARPER, R. H. HAGEMAN, AND D. B. PETERS. Improved nodulation of soybeans grown hydroponically on urea compared with plants grown on nitrate. Agronomy Absts., p. 77. (August 1975).

WARANYUWAT, AREE. The relative performance of some isogenic lines of soybeans (Glycine max L. Merr.). Ph. D. Thesis, Dept. of Agronomy, Univ. of Illinois, (May 1976), R. L. Cooper, major professor. (1976).

WAX, L. M., W. R. NAVE, AND R. L. COOPER. Weed control in narrow and wide row soybeans. Weed Sci. (In Press). (1976).

WILSON, R. F. AND R. W. RINNE. The involvement of phospholipids in triglyceride biosynthesis by developing soybean cotyledons. Plant Physiol. 56:7. (Suppl.). (August 1975).

WILSON, R. F. AND R. W. RINNE. Changes in lipid composition of soybean cotyledons due to freezing injury. Plant Physiol. 56:7. (Suppl.). (August 1975).

WILSON, RICHARD F. AND ROBERT W. RINNE. Effect of freezing and cold storage on phospholipids in developing soybean cotyledons. Plant Physiol. 57:270-273. (1976).

WILSON, RICHARD F. AND ROBERT W. RINNE. Studies on lipid synthesis and degradation in developing soybean cotyledons. Plant Physiol. 57:375-381. (1976).

COLUMBIA, MO:

GEBHARDT, M. R. AND D. R. JOHNSON. A systems approach to soybean production. Proc. of the American Seed Trade Association Meeting, Chicago, Ill. (1976).

MAJOR, D. J., D. R. JOHNSON, AND V. D. LUEDDERS. Evaluation of eleven thermal unit methods for predicting soybean development. Crop Sci. 15: 172-174. (1975).

Ames, IA:

CARLSON, B. E., T. J. BANDSTRA, W. R. FEHR, AND R. C. CLARK. Modification of a self-propelled plot combine for harvesting hill plots of soybeans. Crops Sci. 15:869-870. (1975).

PALMER, R. G. AND H. E. HEER. Aneuploids from a desynaptic mutant in soybeans. Cytologia 41:45-55. (1976).

TACHIBANA, H. The place and promise of biological management of pests in annual cropping systems. Iowa State Jour. Res. 49:583-589. (1975).

TACHIBANA, H., A. H. EPSTEIN, R. F. NYVALL, AND R. A. MUSSELMAN. Phytophthora root rot of soybean in Iowa: Observations, Trends and Control. Plant Dis. Reptr. 59:994-998. (1975).

URS, N.V. R. AND J. M. DUNLEAVY. Enhancement of the bactericidal activity of a peroxidase system by phenolic compounds. Phytopathology 65:686-690. (1975).

Davis, CA:

BEARD, B. H. Soybean research in California, 1975. Soybean Digest. (In Press). (1975).

BEARD, B. H. AND P. F. KNOWLES. Plant breeding to increase protein from proteinaceous crops. Opportunities to improve protein quality and quantity for human food. Calif. Agric. Ext. Serv. Special Publication. (Beard, B. H. and M. D. Miller, Editors). May. (1976)

Peanuts

Suffolk, VA:

BEUTE, M. K., D. M. PORTER, AND B. A. HADLEY. Control of Schlerotinia blight of peanuts. Plant Dis. Repr. 59:697-701. (1975).

COFFELT, T. A., R. W. MOZINGO, E. T. KORNEGAY, AND H. R. THOMAS. The effect of variety and grade on peanut protein quality. Proc. Amer. Peanut Res. and Ed. Assn. 7(1):4-11. (1975).

COFFELT, T. A. AND K. H. GARREN. Reaction of Spanish and Virginia type peanut cultivars to Cylindrocladium black rot. Agronomy 67:49. (Abstract). (1975).

GARREN, K. H. AND T. A. COFFELT. Reaction to Cylindrocladium black rot in Virginia-type peanut cultivars. Plant Dis. Repr. 60(2):175-178. (1976).

KORNEGAY, E. T., H. R. THOMAS, R. W. MOZINGO, T. A. COFFELT, AND J. D. HEDGES. Evaluation of the amino acid content and the proximate composition of several varieties and grades of peanuts. VPI Res. Div. Rept. 163, p. 197. (1974-75).

PORTER, D. M., M. K. BEUTE, AND J. C. WYNNE. Resistance of peanut germplasm to Scerotinia sclerotiorum. Peanut Sci. 2:78-80. (1975).

POWELL, N. L., D. M. PORTER, AND D. E. PETTRY. Use of aerial photography to detect Sclerotinia blight in peanut fields. J. Amer. Peanut Res. and Educ. Assoc., Inc. 7:80. (Abstract). (1975).

POWELL, N. L., D. M. PORTER, AND D. E. PETTRY. Use of aerial photography to detect diseases in peanut fields. I. Sclerotinia blight. Peanut Sci. 3:21-24. (1976).

POWELL, N. L., G. J. GRIFFIN, K. H. GARREN, AND D. E. PETTRY. Use of aerial photography to detect diseases in peanut fields. II. Cylindrocladium black rot. Peanut Sci. 3:25-29. (1976).

Tifton, GA:

ANON. Fellows of the American Society of Agronomy elected in 1975: Ray O. Hammons. Agron. Jour. 68(1):154. (Jan.-Feb. 1976).

GOODIN, PEGGY L. AND RAY O HAMMONS. Broader genetic base seen for peanut breeding. The Oklahoma Peanut 11(2):7. (Feb. 1976).

HAMMONS, RAY O., PETER Y. P. TAI, W. J. ETHREDGE, AND J. S. DREXLER. A review of peanut variety trials in Georgia for 1975. Southeastern Peanut Farmer (Tifton, GA), 14(1):11. (Jan. 1976).

HARTZOOK, A., R. O. HAMMONS, AND C. T. YOUNG. Arginine maturity index (AMI) as a means of determining the growing period in peanuts. Hassadeh 55(10): 1616-1618. In Hebrew; Eng. Sum. (July 1975).

MINTON, N. A. AND R. O. HAMMONS. Evaluation of peanut for resistance to the peanut rootknot nematode, Meloidogyne arenaria. Plant Dis. Reprtr. 59(12):944-945. (A 6-page supplement listing the 512 entries tested is available upon request.) (Dec. 1975).

MIXON, A. C. AND K. M. ROGERS. Factors affecting Aspergillus flavus Lk. ex Fr. colonization of resistant and susceptible genotypes of Arachis hypogaea L. Peanut Sci. 2:18-21. (Fall 1975).

MIXON, A. C. Peanut variety performance in Alabama. Southeastern Peanut Farmer (Tifton, GA), 14(3):8B-9B. (March 1976).

SOWELL, G., D. H. SMITH, AND R. O. HAMMONS. Resistance of peanut plant introductions to Cercospora arachidicola Hori. Plant Dis. Reprtr. 60(6): (In Press). (June 1976).

Stillwater, OK:

BANKS, D. J. Peanuts: germplasm resources. Crop Science (Accepted for July-August issue, 1976).

College Station, TX:

KETRING, D. L. Screening plant growth regulators for peanut plants. Proc. Amer. Peanut Res. and Educ. Assoc., Inc. 7:74. (Abstract). (1975).

KETRING, D. L., C. R. BENEDICT, AND M. YEAGER. Growing season and location effects on water uptake and drying rates of peanut seeds (Arachis hypogaea L.) from genotypes resistant and susceptible to invasion by Aspergillus flavus Lk. ex. Fr. Agronomy. (July-August, 1976).

Flax

Brookings, SD:

Dybing, C. D. High- and low-yielding flax lines for use in studies of physiological limitation of yield. Flax Inst. of the U.S., Proc. 45:11-14. (1975).

Fargo, ND:

HOES, J. A. AND D. E. ZIMMER. New North American races of flax rust, products of natural hybridization. Plant Dis. Reprtr. (In Press). (1976).

HOES, J. A. AND D. E. ZIMMER. Races of flax rust occurring in 1974 and 1975 in western Canada and the northern United States. Plant Dis. Reprtr. (In Press). (1976).

STATLER, G. D. AND D. E. ZIMMER. Inheritance of virulence of race 370, Melampsora lini. Can. J. Bot. 54:73-75. (1976).

THOMPSON, T. E. Cooperative flax trials in the spring flax region - 1975. Mimeograph Report, 35 pp. (1975).

THOMPSON, T. E. Haploid breeding technique for flax. Agronomy Absts, p. 65. (1975).

THOMPSON, T. E. Negative graft-transfer of cytoplasmic male-sterility in flax. Proceedings of the 45th Annual Flax Institute of the United States. (1975).

THOMPSON, T. E., J. J. HAMMOND, AND D. E. ZIMMER. Culbert - a new high yielding rust resistant flax variety. North Dakota Farm Research 33:19-20. (1975).

THOMPSON, T. E. AND D. E. ZIMMER. Plot 30: Proving ground for wilt resistant flax varieties. North Dakota Farm Research 32:28-29. (1975).

ZIMMER, D. E. AND G. D. STATLER. Genetics of rust resistance of six Argentinian flax introductions. Phytopathology 66:661-663. (1976).

Sunflowers

Beltsville, MD:

ORELLANA, R. G. Photoperiod influence on the susceptibility of sunflower to *Sclerotinia sclerotiorum* stalk rot. Phytopathology 65:1293-1298. (1975).

Fargo, ND:

ALESSI, J. AND D. C. ZIMMERMAN. Response of sunflowers to planting date, population, and row-spacing in Northern Plains. Crop Sci. (In Press). (1976).

COBIA, D. AND D. E. ZIMMER. Sunflowers - Production, pests, and marketing. Extension Bull. 25, N. D. State Univ., pp 60. (1975).

DOMINGUEZ GIMENEZ, J. AND G. N. FICK. Fertility restoration of cytoplasmic male-sterility in wild sunflowers. Crop Sci. 15:724-726.

FICK, G. N. AND C. M. SWALLERS. Intercultivar competition in sunflower test plots. Agronomy 67:743-745. (1975).

FICK, G. N. AND D. E. ZIMMER. Linkage tests among genes for six qualitative characters in sunflowers. Crop Sci. 15:777-779. (1975).

FICK, G. N. AND D. E. ZIMMER. Influence of rust on performance of near-isogenic sunflower hybrids. Plant Dis. Repr. 59:737-739. (1975).

FICK, G. N., D. E. ZIMMER, J. DOMINGUEZ GIMENEZ, AND D. A. REHDER. Fertility restoration and variability for plant and seed characters in wild sunflowers. Proc. Sixth Intl. Sunflower Conf., Bucharest, Romania, p. 333-338.

FICK, G. N. Performance of sunflowers in central and western North Dakota. N. Da., Farm Res. 32(5):30-32. (1975).

FICK, G. N. Genetics of floral color and morphology in sunflowers. J. Heredity. (In Press). (1976).

FICK, G. N. AND D. E. ZIMMER. Yield stability of sunflower hybrids and open-pollinated varieties. Proc. Seventh Intl. Sunflower Conference, Krasnodar, USSR. (In Press). (1976).

FICK, G. N., D. E. ZIMMER AND T. E. THOMPSON. Wild species of *Helianthus* as a source of variability in sunflower breeding. Proc. First Sunflower Forum, Fargo, ND. (In Press). (1976).

VICK, B. A. AND D. C. ZIMMERMAN. Lipxygenase and hydroperoxide lyase in germinating watermelon seedlings. Plant Physiology. (In Press). (1976).

ZIMMER, D. E. AND G. N. FICK. Diseases of sunflowers in the United States--their occurrence, biology and control. Proc. Sixth Intl. Sunflower Conf., Bucharest, Romania, p. 673-680. (1975).

ZIMMER, D. E. AND DALE REHDER. Rust resistance of wild *Helianthus* species of the North Central United States. Phytopathology 66:208-211. (1976).

ZIMMER, D. E. Some biotic and climatic factors influencing sporadic occurrence of sunflower downy mildew. Phytopathology 65:751-754. (1976).

ZIMMER, D. E. AND G. N. FICK. Epidemiological and biological factors influencing rust and downy mildew of sunflowers. Proc. National Sunflower Forum, Fargo, ND. (In Press). (1976).

ZIMMERMAN, D. C. AND B. A. VICK. The identification of linoleate hydroperoxide lyase in germination of watermelon seedlings. (Abstract). American Soc. of Plt. Physiologist Meeting, Corvallis, Oregon. (1975).

ZIMMERMAN, D. C. Delineation of moisture content in sunflower seeds with electronic moisture testers. J. Am. Oil Chemist Society. (In Press). (1976).

ZIMMERMAN, D. C. AND D. E. ZIMMER. Influence of freezing temperatures on sunflower seed germination. Crop Sci. (In Press). (1976).

ZIMMERMAN, D. C. Determination of moisture content in sunflowers with electronic moisture meters. Proc. Natl. Sunflower Forum. (In Press). (1976).

Davis, CA:

BEARD, B. H. AND P. F. KNOWLES. Plant breeding to increase protein from proteinaceous crops. In: Opportunities to Improve Protein Quality and Quantity for Human Food. Calif. Agric. Ext. Ser. Special Public. (Beard, B. H. and M. D. Miller, editors). (May 1976).

BEARD, B. H., PHREK GYPMANTASIRI, AND K. H. INGEBRETSEN. Date of planting and spacing effects on yield, oil content and fatty acid composition of sunflower. National Sunflower Form. (In Press). (1976).

BEARD, B. H., E. C. CARLSON, P. GYPMANTASIRI, ALAN JOHNSON, K. H. INGEBRETSEN, AND J. M. KLISIEWICZ. Maximum yields of seed and oil from sunflowers. National Sunflower Grower. (Sept. 1975).

KLISIEWICZ, J. M. AND B. H. BEARD. Diseases of sunflower in California. Plant Dis. Repr. 60: (In Press). (1975).

Safflower

Beltsville, MD:

THOMAS, C. A. Resistance of VFR-1 safflower to Phytophthora root rot and its inheritance. Plant Dis. Repr. 60(2):123-125. (1976).

Tucson, AZ:

ZIMMERMAN, L. H. Genetics of time of internode elongation and duration of rosette habit in Carthamus tinctorius L. and C. flavesens Spreng. Crop Science. (Advised that it will probably appear in May-June 1976 issue).

Davis, CA:

BINDER, R. G., W. F. HADDON, R. E. LUNDIN, A. C. WAISS, AND J. M. KLISIEWICZ. 1, 8, 11, 14--Heptadecatraene from Carthamus tinctorius. Phytochemistry 14: 2085-2086. (1975).

BOCKLEMAN, H. E., P. F. KNOWLES AND J. M. KLISIEWICZ. Inheritance of resistance of safflower (Carthamus tinctorius L.) to race 3 of Fusarium wilt. Crop Science. (In Press). (1975).

KLISIEWICZ, J. M. Race 4 of Fusarium oxysporum f. sp. carthami. Plant Dis. Repr. 59:712-714. (1975).

URIE, A. L., W. F. PETERSON, AND P. F. KNOWLES. "Notice of Oleic Leed Safflower." (1976).

URIE, A. L. "Notice of release of partial hull oleic safflower germplasm." (1976).

URIE, A. L., L. H. ZIMMERMAN, C. A. THOMAS, W. F. PETERSON, AND P. F. KNOWLES.
"Registration of VFstp-1 safflower germplasm." Submitted to Crop Science,
Jan. 26. (1976).

Guar

Vernon, TX:

ROGERS, C. E. Effects of simulated damage by midges on seed production by guar. J. Econ. Entomol. 68:832-834. (1975).

ROGERS, C. E. AND STAFFORD, R. E. Budding phenology of guar in the rolling plains of Texas. Agron. Jour. 68:496-499. (1976).

STAFFORD, R. E. Kinman and Esser, new guar varieties. TAES Leaflet, L-1356. (1975).

STAFFORD, R. E. AND C. R. LEWIS. Natural crossing in guar, Cyamopsis tetragonoloba (L) Taub. Crop Sci. 15:876-877. (1975).

STAFFORD, R. E., M. L. KINMAN, L. E. BROOKS, AND C. R. LEWIS. Registration of Brooks, Hall and Mills guar. Crop Sci. 16:309. (1976).

STAFFORD, R. E., J. S. KIRBY, M. L. KINMAN, AND C. R. LEWIS. Registration of Kinman and Esser guar. Crop Sci. 16:310. (1976).

NRP Annual Report
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NRP 20090 Breeding and Production--Sugar Crops

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- TO 1. Develop new and improved breeding lines and varieties that combine high yielding potential and favored quality characters with better pest resistance, drought-cold-salt tolerance, and adaptation to mechanized culture, harvesting, handling, and storage.

Sugarcane

Techniques were developed to assay pollen viability and to store pollen up to 10 days. Because sugarcane varieties flower on different dates, flowering must be synchronized or stored pollen used to establish a broad genetic base from which to select improved varieties (Aiea, HI).

Sucrose at 20 percent in a medium of Muroshige-Skoog mineral salts supported 1 week longevity of microspores in sugarcane anthers. Some amino acids improved longevity. Production of haploids is the goal of this tissue culture project (Aiea, HI).

Intact sugarcane plants under moisture stress produce increased quantities of free prolines in leaf tissues. Isolated leaf discs show the same reaction when subjected to drought simulated by polyethylene glycol as an osmoticum. Proline production is increased by abscissic acid. Variety differences in proline production when under moisture stress may provide a means of selecting for drought tolerance (Aiea, HI).

Development of haploid cell lines in plants, a necessary prerequisite for much parasexual hybridization, has not yet been accomplished, but microspore longevity was extended by 2 weeks and extra cell divisions were observed when anthers were cultured in the best media (Extramural Aiea, HI).

At least some resistance to smut is based on physical barriers such as bud scales. Chemical and heat therapy kills smut spores in true seed as well as on seed pieces. Neither therapy treatment appears to predispose newly germinated plants to smut (Extramural - Aiea, HI).

A large percentage of spores released from the smut whip on humid days drop to the ground or foliage near the inoculum source. On sunny days viable spores have been trapped 5 to 10 miles down-wind from infected fields. Viable spores have also been found in insect stomachs (Extramural - Honolulu, HI).

Research indicates that resistant plantlets can be produced from callus tissue of clones having susceptibility to disease. Several thousand plantlets derived from smut resistant clones by tissue culture were shipped to Fiji to be tested for resistance to Fiji disease of sugarcane (Extramural - Aiea, HI).

In order to develop a large number of seedlings with smut resistance, 2,000 new clones were imported to the Oahu breeding station, and 1,500 crosses were made to produce seed which is now being germinated (Extramural - Aiea, HI).

Two hundred and forty-three sugarcane clones were imported from other countries or states and placed in the quarantine system. There were 832 seedlings and 159 clones that represent new germplasm released from quarantine for use in U.S. breeding programs. In addition, 32 clones were released from quarantine and the germplasm collection for breeding programs in Egypt, Australia, Bangladesh, Sudan, Philippines, Liberia, and India (Beltsville, MD).

Bacterial counts of sugarcane juice samples showed promise as a method for screening for clones resistant to ratoon stunting disease (RSD). Counts were made using phase contrast microscopy. Clones known to be susceptible to RSD injury had higher bacterial counts than clones known to be resistant or tolerant (Beltsville, MD).

In the first ratoon crop of final replicated tests, CP 70-1133 produced 125 percent more sugar per acre than CP 63-588, the leading commercial variety. Seed supply is being increased for release in 1977 (Canal Point, FL).

Two varieties, CP 68-1026 and CP 68-1067 were released for commercial culture in Florida in the fall of 1975. These varieties produced 17 and 18 percent more sugar per acre than CP 63-588 as an average of plant, first ratoon, and second ratoon crops in final replicated tests (Canal Point, FL).

CP 65-357, previously released in Louisiana, was distributed to Florida sugarcane growers in the fall of 1975. It yielded 121 percent more sugar per acre than CP 63-588 in final replicated tests (Canal Point, FL).

Data collected to construct a selection index showed that expected genetic advance was 91.4 percent as great when selection was based on the yield components, stalk number, stalk diameter, stalk length, and Brix, as when selection was based on yield of sugar per acre itself (Canal Point, FL).

One clone, US 72-1288, was shown to have superior cold tolerance after several freezes in tests on the University of Florida Agronomy Farm at Gainesville, FL. Stalks of US 72-1288 were undamaged while stalks of all other varieties were frozen throughout and soured (Canal Point, FL).

A method was developed for long term storage of sugarcane mosaic virus in a suitable form for sampling with no change in activity. Use of this constant activity inoculum showed that there are diurnal rhythms in susceptibility of sorghum host plants (Canal Point, FL).

There were 325 varieties sent to 34 countries from the CP and World Germplasm Collection (Canal Point, FL).

Near immunity to sugarcane mosaic virus was identified in the wild species, Saccharum spontaneum (Houma, LA).

Twelve Saccharum officinarum clones were induced to flower for the first time in the U.S. and used successfully in crosses to establish new breeding lines (Houma, LA).

Mosaic resistant clones with good agronomic type and high sugar yield were identified in the cross CP 65-357 X L 65-69 (Houma, LA).

CP 67-412 was released for commercial culture in Louisiana in 1975. It had the highest yield in ratoon crop tests on heavy soil (Houma, LA).

Six commercial varieties were evaluated for harvester response at 18 locations. The commercial varieties NCo 310 and CP 52-68 had less ground loss than other varieties in the tests (Houma, LA).

Progress toward development of mosaic resistant varieties for the Louisiana sugarcane industry was evident in the 71 series varieties. Six of 20 varieties showed moderate resistance and one variety, CP 71-439, was as resistant as L 65-69, the only highly resistant commercial variety in Louisiana (Houma, LA).

Approximately 1,000 plants derived from tissue culture were transplanted to the field. No visible morphological changes were apparent. Substitution of 2-4-5-T, dicamba, and picloram for 2-4-D in starting media resulted in callus formation and subsequent plantlet differentiation with two varieties, NCo 310 and CP 65-357. Dalapon did not induce callus (Houma, LA).

Several chemical ripeners were tested on a number of varieties. Polaris continued to increase sugar per ton but decrease tonnage in many tests with infrequent increase in sugar per acre. No ripener was consistently active with all varieties (Houma, LA).

Two levels of mosaic infection in seed cane, 50 percent and 75 percent, reduced yields of several varieties. Strain I reduced yield more than Strain H. Yield of the commercial variety, NCo 310, was reduced 18.2 tons/acre when 100 percent infected with Strain I. Transmission tests showed that Strain I was transmitted more frequently by aphids than Strain M, and the Strain H isolate was not transmitted by aphids. All strains were transmitted mechanically. Other isolates of Strain H are aphid transmissible (Houma, LA).

Ratoon stunting disease reduced cane yield in 7 of 8 varieties. CP 68-361 was tolerant. RSD and mosaic in combination with two common herbicides caused yield reduction but no interaction of diseases and herbicides was detected (Houma, LA).

Seedlings in the greenhouse showed irregular brown patches on leaves and Rhizoctonia solani was the causal organism. The organism caused banded sclerotial disease in field grown cane. Pineapple disease (Ceratocystis paradoxa) was implicated in poor germination of commercial sugarcane varieties. The fungus was isolated from 86 percent of ungerminated seedpieces and 95 percent of soil samples from sandy loam soil (Houma, LA).

Four Mer. selections with high yield and quality of sirup per acre were advanced for additional testing (Meridian, MS).

Sugarbeet

Two monogerm male sterile Beta maritima found in 1955 have been backcrossed four times. Crosses to sugarbeet O-types have been identified cytoplasmic male-sterile lines. All these lines have leaf spot resistance equal to the resistant check but less foliage vigor (Beltsville, MD).

There were 58 new monogerm maintainer lines located in backcross material in 1975 and the 12 most promising lines will be increased (Beltsville, MD).

Beets selected for ozone susceptibility contained 20 percent less non-sucrose solubles than the check variety. This relationship may offer a means of selecting for improved purity (Beltsville, MD).

Gradual progress in decreasing soil adhering to the root has been made by selection in a sugarbeet cultivar. "Soil-free" segregates, both globe shaped and spindle-shaped, were recovered by selection in B₃ progenies of sugarbeet x garden beet crosses but sucrose content is only 70 percent of commercial beets (Beltsville, MD).

Four breeding lines were distributed to industry breeders. EL 36 and its CMS equivalent EL 36C2 are high yielding, *Cercospora* and *Aphanomyces* resistant monogerm female components for use in hybrids. EL 42 and EL 43 are multigerm pollinator components with improved *Rhizoctonia* resistance, yielding ability, and processing quality (East Lansing, MI).

Several experimental hybrids were made available to companies for testing and 246 breeding lines were tested for agronomic performance. Many lines were evaluated for resistance to *Aphanomyces cochlioides*, *Rhizoctonia solani*, *Cercospora beticola*, and *Erysiphe polygoni*. There were significant differences in disease reaction, and roots from superior entries were selected as sources of resistance in the breeding program (East Lansing, MI).

The pH of nutrient medium, length of inoculation period, and surface area of culture vessel were important factors affecting production of *A. cochlioides* oospore inoculum in vitro. Both components and ratios in potting mixes affected blackroot disease development in sugarbeet seedlings exposed to *A. cochlioides* oospore inoculum in greenhouse tests (East Lansing, MI).

There were differences in virulence among 31 isolates of *Rhizoctonia solani* collected in Michigan and Ohio, but the line FC 701/5 was resistant to all isolates (East Lansing, MI).

A sand emergence technique was developed to detect and discard seedlots with good germination but poor emergence power (East Lansing, MI).

Only nine of 4,100 roots from Russian lines introduced 2 years ago were resistant to the three storage rot pathogens *Phoma betae*, *Botrytis cinerea*, *Penicillium cloviforme*. Russians claim that resistance to *B. cinerea* implies resistance to the other two pathogens. The nine resistant roots were included in a recurrent breeding scheme for improvement and increase (Fargo, ND).

Four breeding lines with moderate resistance to either *P. betae*, *B. cinerea* or both will be released for use by industry breeders (Fargo, ND).

Correlation was .72** for internal CO₂ levels between progeny means and parents when parents were selected for high and low internal CO₂ level. Preliminary data showed a positive correlation between internal CO₂ level and respiration rate. More rapid progress in developing varieties with low respiration rates can be made if internal CO₂ level is an adequate indicator of respiration rate (Fargo, ND).

Genetic experiments revealed partial dominance for resistance to *Rhizoctonia solani* and when combined with a beneficial triploid effect, resistance may be necessary in only one parent of commercial hybrids. Several breeding lines had good resistance to *Rhizoctonia* and three other diseases in 1975 tests. Several experimental hybrids with

Rhizoctonia-resistant lines were equal in sucrose production to susceptible commercial hybrids (Fort Collins, CO).

Several Fort Collins lines resistant to leaf spot and curly top crossed with Logan lines highly resistant to curly top produced progeny with good resistance to both diseases (Fort Collins, CO).

Seven breeding lines, FC101 through FC107, resistant to Botrytis cinerea were made available to sugarbeet breeders. Five lines are for use as pollinators and two lines are for use as monogerm source of resistance to B. cinerea (Fort Collins, CO).

Sucrose yield was reduced 6.2, 20.1, and 24.5-38.1 percent when leaf spot ratings (on a 0-10 scale) were 2.1, 3.3, and 6.1-6.4, respectively. Root weight was reduced the most, followed by sucrose content and juice purity (Fort Collins, CO).

Cercosporin, a phytotoxic pigment produced by the fungus Cercospora beticola, was isolated from infected sugarbeet leaves. In vitro, cercosporin production was significantly higher on potato dextrose agar (PDA) than on 4 other agar media tested, and there were significant differences in amount of cercosporin produced on PDA by 3 fungal isolates. Application to sugarbeet leaf surfaces of cercosporin in 50 percent EtOH produced necrotic lesions that showed ultrastructural similarities to lesions of the fungus-induced disease. The possible phytoalexin betavulgarin (BV; 2'-hydroxy-5-methoxy-6,7-methylenedioxyisoflavone) was localized in and immediately around C. beticola-induced lesions on sugarbeet leaves. BV significantly inhibited growth of C. beticola on PDA. Whole leaf content of BV was significantly positively correlated with mean sugarbeet leaf spot disease rating, perhaps because susceptible cultivars having a high disease rating also had many more lesions than resistant ones (Fort Collins, CO).

Extract type X beet chemistry interaction was demonstrated for four sugarbeet quality-determining components (Na, K, amino N, and betaine), and may explain inconsistencies in literature data. Refrigeration or freezing lead-cleared sugarbeet filtrates slightly but significantly affected quality component analyses, illustrating the need to standardize sample storage methods. In three exact types, despite significant among-extract numerical differences, the correlation coefficient between extract pairs was always above 0.94, confirming that each extract could be used for quality analysis (Fort Collins, CO).

In experiments on sugarbeet quality, betaine, potassium, sodium, nitrate N, and amino N were found to be the most important soluble non-sucrose constituents affecting sugarbeet thin juice purity over widely differing environmental conditions. Models developed which included these components and sucrose accounted for up to 88 percent of the

variation in purity in 1974 and up to 87 percent in 1975. In general, these soluble nonsucrose constituents increased in quantity from high plant population density to low density but did not produce a significant effect on models constructed to account for thin juice purity at high or low nitrogen fertility. The type of gene action controlling these components should allow genetic modification of the components that directly and indirectly affect purity, resulting in more rapid progress than by breeding for purity per se (Fort Collins, CO).

A preliminary experiment on the effect of polyploidy on sugar yield components provided evidence that different component relationships may exist at different ploidy level. More extensive experiments will reveal if the positive effects are independent and can be genetically recombined to increase sugar yield (Fort Collins, CO).

Several promising cultivars with resistance to powdery mildew have been identified by using a greenhouse evaluation procedure (Logan, UT).

There were 1,000 sugarbeet breeding lines from throughout the U. S. evaluated in the field for curly top resistance (Logan, UT).

A laboratory method was adapted for testing for resistance to storage rot fungi (Logan, UT).

Diameter of sugarbeet hypocotyl at 20 days after emergence can be used to accurately predict root yield. Two lines, selected for high and low hypocotyl diameter, differed by 25 percent in hypocotyl diameter and 30 percent (6 tons/acre) in harvest root yield. Adoption of the technique in a recurrent selection program will reduce the time of variety development by at least one-half (Logan, UT).

Selection for high competitive ability and positive competitive influence increased harvest root yield. This suggests that greater progress can be achieved by considering these genotypic competition factors in a breeding program (Logan, UT).

Thirteen morphological and physiological factors were evaluated in a growth-analysis study of 24 inbreds and hybrids differing in sugar content, root yield, and combining ability. Heterosis and differences in magnitude of heterosis were observed for all factors measured. Hybrids had a higher percent water in the petioles than the inbreds but were not different for the other plant parts. Percent dry matter of blades, petiole, and root were correlated with each other and with percent sugar and vascular-ring number. Root-fresh weight was correlated with root diameter. Heterosis for vascular-ring number was correlated with heterosis for percent sugar. Vascular rings grew at approximately the same rate once initiation occurred. Percent sugar was a function of water in the root and not dry matter. Measurements of relative root-sink strength showed a close relationship with root yield (Logan, UT).

Comparison of inbreds and hybrids in a space-planted nursery demonstrated that the morphological characteristics of F₁ hybrids have no consistent relationship with the morphology of their inbred components. Hybrids begin decreasing in average leaf area in the fall sooner than do the inbreds. Early growth and leaf area are associated with root weight. Heterosis appears evident for leaf area, leaf width, leaf length, root/top ratio, number of leaves, and number of dead leaves (Logan, UT).

An intensive genetic study of curly-top resistance was conducted between three resistant and three susceptible sources to curly-top. Curly-top resistance is governed by both additive and non-additive gene action. A preliminary model of at least three additive genetic factors and two dominant factors was proposed for curly-top resistance (Logan, UT).

Excessive nitrogen increased root yield but reduced sugar percent and increased the concentration of impurities in the root. Different moisture levels had an effect on yield but had no influence on percent sugar and impurity concentration. Different genotypes reacted differently to varying levels of nitrogen. USH20 yielded almost as well at low as at high nitrogen levels. Its percent sugar and impurity concentrations were influenced very little by high nitrogen levels; whereas, hybrid L53 X A7135 responded significantly to high nitrogen levels with higher root yield, lower percent sugar, and higher impurity concentrations. All genotypes reacted similarly to different water levels (Logan, UT).

Storage of a diallel cross among eight sugarbeet inbreds confirmed data of a previous year. Both general and specific combining ability were significant indicating that respiration rate is governed by both additive and non-additive gene action. Hybrids respired at a lower rate than the inbreds, and the higher yielding lines respired more slowly than the lower yielding lines. There was no correlation between sucrose content and respiration rate. Results correlated with mitochondrial efficiency studies, suggesting that hybrids required less substrate to provide the necessary ATP for maintaining cellular integrity of the stored root than do inbreds. The results indicate good potential for selecting cultivars with low-storage respiration rates (Logan, UT).

Approximately 9,000 beet plants in 306 introduction lines of Beta were screened for new potential sources of sterile cytoplasm. Only about 8 percent of the lines had male-sterile segregates. Test-crosses for some of the male steriles have been made to evaluate their stability and to determine whether the male-sterility is governed by genetic factors or by interaction of genetic and cytoplasmic factors. A cytoplasmic male-sterile from Beta maritima and one developed in Germany were crossed to selected inbred stocks to determine if these sources of male-sterility are identical to the currently used source of male-sterile plasm (Logan, UT).

A non-pollen restoring pollinator was selected and tested that will produce hybrids equivalent to commercial cultivars except that the commercial beets do not set seed. This approach would eliminate the weed beet problem in California and Arizona where winter-planted and overwintered beets often produce large quantities of seed (Salinas, CA).

Comparison of S_1 progeny, pair crossed, and test cross evaluation trials showed the greatest discrimination of S_0 genotypes to be for the S_1 progeny for all traits evaluated, including sugar yield, beet yield, sucrose percentage, powdery mildew resistance, and concentrations of the molassigenic substances, amino nitrogen, sodium, and potassium (Salinas, CA).

Field and greenhouse selections for resistance to root rot of sugarbeet incited by Erwinia have proven successful. Several of these selections show promise as potential pollinators of commercial hybrids equivalent in other traits to the presently grown hybrids. In field tests in which parental lines and their segregating progeny were injured and inoculated with Erwinia, the distribution of resistant and susceptible plants suggested that resistance was at least partially due to one dominant factor (Salinas, CA).

The gene BM that conditions a high level of resistance to beet mosaic virus (BMV) was shown to essentially eliminate the losses in sugar yield due to BMV infection. However, this resistant allele was again shown to be associated or linked with factors that influence sucrose percentage and virus yellows resistance (Salinas, CA).

Comparison of corresponding diploid and triploid hybrids involving curly top resistant female parents and yellows resistant C17 (2n) and (4n) pollen parents showed that triploids do not necessarily produce higher sugar yields than diploids. Undesirable characteristics such as disease susceptibility may be more damaging in triploid hybrids when susceptibility is associated with the tetraploid parent (Salinas, CA).

A large collection of sugarbeet varieties and lines from all parts of the United States and from Western Europe were evaluated for powdery mildew resistance. A wide range in resistance was observed but none of the entries proved to be immune or highly resistant. Curly top resistant varieties developed by ARS and the sugar companies tended to be susceptible. Opportunities exist for improving the resistance of our commercial varieties, but resistance may need to be introduced from curly top susceptible material (Salinas, CA).

Losses from yellows viruses and powdery mildew were essentially additive. It should be possible to combine mildew resistance and yellows resistance in the same line (Salinas, CA).

A segment of a Beta procumbens chromosome bearing the gene or genes for nematode resistance was transferred to a *B. vulgaris* chromosome. Many diploid nematode resistant plants have been obtained, but the frequency of resistance transmission in these plants is low. The transmission rate in F₂ progenies from F₁ nematode resistant plants varied from 7 to 27 percent. Selections have been made from F₂ progenies with the highest transmission rates. Tests with the F₃ progenies from these selections also showed a high transmission rate (Salinas, CA).

Four lines were made available for increase and utilization in breeding programs. C22 is self-sterile and yellows resistant. C31 is self-sterile, bolting resistant, and possesses good combining ability for sugar. C706 is a monogerm inbred resistant to bolting and yellows virus. C706H0 is the CMS equivalent of C706 (Salinas, CA).

Sweet Sorghum

In three sweet sorghum crosses, hybrid vigor was expressed as an increase of 10.1 tons of millable stalks per acre and 1.7 degrees Brix. In 26 crosses, hybrid vigor was expressed through superior yield of stalks (Meridian, MS).

Cytoplasmic male sterile lines of Brawley, Collier, and Tracy were crossed with Rio to transfer CMS to Rio and to identify B and R lines of Rio for use of CMS in sweet sorghum for sugar production (Meridian, MS).

More than 600 MN selections from the World Sweet Sorghum Collection are being evaluated for yield, disease resistance, juice quality, and the seed supply replenished (Meridian, MS).

There were 520 lines screened for resistance to leaf anthracnose, bacterial stripe, gray leaf spot, insecticide injury, pokka boeng, rough spot, rust, and zonate leaf spot (Meridian, MS).

A spray technique was developed to evaluate sweet sorghum for resistance to maize dwarf mosaic virus. There was no correlation between percent infection and severity of injury in 60 cultivars (Meridian, MS).

- TO 2. Develop new and improved cultural and management practices to increase sugar and sirup yields, minimize production losses, improve quality attributes, and efficiently conserve scarce resources.

Sugarcane

Yield increase from gibberellic acid (GA_3) ranged from 0.27 to 0.61 tons of sugar per acre. This amounts to a 4-percent yield increase and a potential profit of approximately \$100/acre. Apparently many varieties are deficient in gibberellic acid during the cool season of the year (Aiea, HI).

Ten isolates of sugarcane mosaic from sugarcane entering the country through the Beltsville quarantine were identified as strains A and F. Comparative studies showed strain F, not present in the U.S., to be similar to U.S. strains (Beltsville, MD).

The coryneform bacterium associated with ratoon stunting disease was maintained on several cultural media, but no proof of prolonged multiplication could be shown. Generally, counts in juice samples were directly related to dilution end points of infectivity of the samples which is further indirect evidence that the bacterium is the causal agent (Beltsville, MD).

August planting was advantageous for L 60-25 and L 62-96. September and October planting was best for CP 65-357 and planting date did not influence yield of CP 61-37 (Houma, LA).

Double drill planting was again tested for yield with rows reduced from 7 to 6.5 ft. Double drills on 6.5 ft rows yield 30 percent, and on 7 ft 20 percent, more than the standard 6 ft single drill row. Difficulties with double drill planting that reduce stubble yield are johnsongrass control and equipment damage. An unreplicated test with row spacing to 1 ft apart showed progressive increases in yield as spacing decreased (Houma, LA).

The efficacy of Paraquat as a leaf dessicant was tested on 10 acres of L 62-96. Cane was burned standing and harvested by combine or burned on the heap row when harvested by a soldier harvester. No improvement in burning was observed when trash contents of treated and untreated cane were compared. Lower trash and higher juice quality were noted in soldier harvested cane compared to combined cane (Houma, LA).

Preliminary experiments showed that field grown, surface sterilized roots of sugarcane, when placed under reduced oxygen pressure, could reduce acetylene to ethylene. This is a reaction used to characterize nitrogen fixation. Cultures made from sections of surface sterilized roots produced a bacterium, which could also reduce acetylene to ethylene (Houma, LA).

Cane trash is usually regarded as an inert sponge in milling, contributing nothing but soaking up 3 percent of its weight in sucrose. Studies on components in different parts of the plant showed that leaf blades were heavy contributors of starch and soluble polysaccharides, both inhibitors of sucrose crystallization. The remainder of the cane top is also rich in fructose and glucose as well as starch which increased during the day. Dead leaves were free of sugars and starch but surprisingly high in soluble polysaccharides and potassium ions. Stubble (free of mud) gave juice rich in sucrose, being comparable to the upper stalk. Young shoots made stubble higher in starch than the lower stalk. Root stumps were free of starch but showed moderate amounts of sucrose and reducing sugars. Juice extraction was not high in the non-stalk portions so that the total contribution of undesirable constituents from all trash was about equal to the amounts already present in mill cane (Houma, LA).

Yield tests on cane infected with ratoon stunting disease and cane treated with hot air or with conventional or serial hot water showed that cane from either hot water treatment gave significantly superior yields compared to hot air treatment. Untreated cane yielded lower than any heat treatment. Hot water treatment of young cane has been risky, but serial hot water treatments of 10 or 20 minutes at 50°C a day before conventional treatment improved survival of cane 2 to 300 percent in July-harvested cane. Previous cures of mosaic involving serial hot water treatment depended on different temperatures on different days (52°, 1st day; 57.3°, 2nd day). Difficulties anticipated in changing temperature with precision in commercial applications led to work on a single temperature serial treatment. A variety of treatments yielded a range of cures and survival rates, but 5 minutes at 57.3° on the first day followed by 15 minutes at the same temperature on the second day gave cures similar to 52° first day treatments. Aerated steam was investigated as a method of curing ratoon stunting disease. An experimental unit at LSU was used to treat cane known to be infected with RSD. Treatment at 49° for 3.5 hours was not effective. Treatments at 50° for 3.5 or 4 hours gave approximately 90 percent cure. Cane used was hand stripped and well spaced as in a hot air treating unit (Houma, LA).

Short seed pieces for fall planting have long been thought to be impractical. Previous experiments indicate that short seed pieces may be used in early plantings. An October planting was made in 1974 comparing combine harvested cane (14") with seed pieces 7", 13", 20", and 72". A depth of covering treatment was superimposed. Combined cane gave the poorest yields, with 7" and 13" yielding significantly more, but less than 20" and 72" seed pieces. Yields from shallow covering were higher than from deep covering (Houma, LA).

CP 36-111 and seven experimental subclones derived from CP 36-111 by tissue culture were the only clones of 30 that were tested that did not have sucrose crystals in the sirup 3 months after processing. Sirup from mixed plantings of CP 36-111, CP 52-48, and CP 67-500 had fewer sucrose crystals than sirup from CP 52-48 and CP 67-500 alone (Meridian, MS).

Sugarbeets

Incidence of Rhizoctonia solani following a corn-beet sequence was lower than following bean-beet sequence. Disease incidence following corn-beet and oats-alfalfa-bean-beet sequences was intermediate. There were no significant differences among 2-, 3-, and 4-year rotation periods and no interaction between cropping sequence and rotation periods (East Lansing, MI).

Rhizoctonia isolates from navy bean were pathogenic on sugarbeet seedlings and older plants. Isolates from cucumber, alfalfa, potato, vetch, eggplant, rutabaga, carrot, flax, and pine were nonpathogenic on sugarbeet (East Lansing, MI).

Control of Cercospora leafspot in artificially inoculated field plots with 11 fungicides ranged from 30-80 percent (East Lansing, MI).

Thiabendazole, benomyl, and wettable sulfur applied twice at 3-week intervals after symptoms appeared were effective in controlling powdery mildew in naturally infected field plots (East Lansing, MI).

Infrared aerial photography showed promise as a method of detecting severity of Aphanomyces cochlioides, Rhizoctonia solani, and Cercospora beticola (East Lansing, MI).

Sterile discs of root tissue for use as controls in juice quality studies of stored sugarbeets can be obtained by treating discs in an antibiotic suspension of streptomycin, chlorotetra-cycline, and pentachloronitrobenzene followed by thorough rinsing in sterile distilled water (Fargo, ND).

A non-pathogenic species of Pseudomonas did not hydrolize sucrose in leaf discs (Fargo, ND).

Storage of sugarbeets below -10° C reduced invert sugar accumulation (Fargo, ND).

In commercial fields, 19 percent of the fresh root weight was crown material. Four to five percent of the crown is removed by normal harvesting procedures. About 20 percent of total factory deliveries consists of crown material. Removal of all crown material slightly improved sucrose content and lowered nitrate levels (Fargo, ND).

Benomyl-tolerant strains of Cercospora beticola were isolated for the first time in Arizona. Increasing concentrations of benomyl decreased growth of benomyl-tolerant strains and reduced viability and length/width ratios of spores (Fort Collins, CO).

Of 30 species tested, only Beta spp. were susceptible to powdery mildew. B. patellaris was highly resistant. Susceptibility of sugarbeet is directly proportional to age between 2 and 16 weeks. The fungus does not survive on plant debris and infested seed is not the primary source of inoculum in Colorado (Fort Collins, CO).

Curly-top virus was specifically located in phloem tissue of bean, tobacco, and tomato with fluorescent antibody staining technique. The curly-top virus has an unusually small diameter of about 17 nm and a sedimentation coefficient of 55.4 S in CsCl. Two virus proteins were identified with molecular weights of 36,400 and 32,800 (Logan, UT).

Mertect and Benlate controlled Penicillium and Botrytis storage rot fungi in agar plate tests and inoculated root tissue. Mertect applied as a mist spray to 4,000 tons of beets as they entered a commercial pile controlled storage rots for 120 days. Both percent sucrose and quality were significantly better in treated beets than in a water control after storage (Logan, UT).

Biochemical and electron microscope studies indicated two pathways of sucrose accumulation into the vacuoles of sugarbeet root-storage cells. In one pathway, sucrose enters the cytoplasm and is hydrolyzed to glucose and fructose. These sugars then enter the metabolic pools of the cytoplasm where they may be utilized in respiration, cell wall synthesis, or they may be converted back to sucrose and stored in the vacuole. An alternate pathway bypasses the cytoplasm by the fusion of the tonoplast and plasmalemma membranes into a fescicle which moves sucrose by pinocytosis from the free space into the vacuole (Logan, UT).

A computer simulation model of a sugarbeet storage pile was further refined and verified using actual commercial pile temperature data. The model has been used to generate information to assist storage pile managers in the proper operation of ventilation fans at subfreezing temperatures (Logan, UT).

Effects of photosynthesis and photorespiration on sugarbeet growth characteristics were determined in growth chambers at low levels of O₂ and high levels of CO₂. Low oxygen (low photorespiration) did not stimulate dry matter production. However, growth in 1,000 ppm CO₂ (high photosynthesis) stimulated growth by 100 percent during a 6-week period. The increased growth was partitioned primarily to the root. In the field season-long treatment with 1,000 ppm CO₂ increased both root and top growth, but a greater proportion of the increased growth was partitioned to the root and to sucrose. These results indicate the potential for substantially increasing sucrose yield per acre by increasing photosynthetic rates (Logan, UT).

A close serological and biological relationship was established between beet western yellows virus, the most prevalent sugarbeet virus in the United States, and beet mild yellowing virus, the most prevalent sugarbeet virus in Europe (Salinas, CA).

Seed yield and seed size of Crambe abyssinica, a potential new oil seed and animal feed crop, were reduced 95 and 40 percent, respectively, when infected with beet western yellows virus (Salinas, CA).

Severe isolates of curly top virus caused serious losses in normally resistant cultivars as late as 10 weeks after seeding. Incubation period of various isolates rather than marked differences in the ability of resistant cultivars to recover was considered to be the major factor in disease reaction (Salinas, CA)

Beet leafhoppers prefer Salsoa iberica to Salsoa paulsenii as a feeding host. Breeding characteristics were not different when feeding on either host (Salinas, CA).

On Sonchus infected simultaneously with beet yellow stunt virus and sowthistle yellow vein virus, annulate lamellae were found in developing vascular cells in which SYVV particles also were present. This is the first time these specialized organelles have been seen in virus-infected plants and, perhaps more importantly, in vacular tissues of any plant. Subcellular responses of Beta to infection with *Cercospora* leafspot have shown collapse and degradative processes in response to the fungus and its product, Cercosporin (Salinas, CA).

Fourteen isolates of Cercospora beticola studied morphologically were found to be either race C1 or C2 since differences between the two races were not large enough to differentiate them into separate species. Resistance to Race C2 is controlled by a single dominant gene (Salinas, CA).

Selection pressure exerted by either greenhouse or field selection methods developed for Erwinia root rot resistance does not appear to affect yield, sucrose percentage, yellows resistance, curly top resistance, or bolting resistance of selections. Further sophistications of an inoculation procedure for powdery mildew have been made (Salinas, CA).

Sweet Sorghum

Bagging the panicle of three varieties of sweet sorghum to prevent cross pollination reduced the juice Brix, sucrose, and purity (Meridian, MS).

The yield of Dale sweet sorghum was not affected by following two successive crops of soybeans treated with single and double rate of treflan. The yield of stalks from nine varieties of sweet sorghum was not affected by 2, 4, or 8 pounds of propazine per acre. The nine varieties showed similar response to preemergence treatment of propazine (Meridian, MS).

Mer. 71-7, a potential sirup variety, failed to boil to sirup density in three of nine tests due to excessive starch in the juice (Meridian, MS).

Mer. 68-2 and Mer. 69-13, potential sugar varieties, exceeded Rio (check) 20 percent and 28 percent, respectively, in yield of sugar per acre from eight tests in Louisiana, Mississippi, and Texas (Meridian, MS).

Seven sweet sorghum cultivars in nine variety tests for sirup production in Alabama, Kentucky, Georgia (2), South Carolina, Florida, and Mississippi (3) were resistant to leaf anthracnose. Mer. 71-7 was infected with MDMV at six of nine locations. Pokkah boeng reduced stalk height 2 feet on 50, 70, and 80 percent of the plants in Mer. 71-1, Brandes, and Theis, respectively, in plots at Quicksand, Kentucky. All cultivars were infected with bacterial stripe, gray leaf spot, rough spot, and zonate leaf spot at one or more locations. Rust infection was found on Mer. 71-1, Mer. 71-7, Dale and Theis (Meridian, MS).

Seven sweet sorghum sugar varieties were indexed for diseases at six locations. Mer. 68-2 was heterozygous for anthracnose infection at Meridian, Mississippi. Downy mildew was observed on Mer. 68-2, Mer. 69-13, Mer. 71-5, Mer. 72-2, and Mer. 72-3 at Weslaco, Texas. Yellow sorghum stunt infected Roma, Ramada, Mer. 71-5, Mer. 72-2, and Mer. 72-3 at Baton Rouge, Louisiana, and College Station, Texas. Bacterial stripe, gray leaf spot, and zonate leaf spot infection was observed on every variety at one or more locations (Meridian, MS).

Significant progress was made in developing a completely mechanized system for harvesting and processing sweet sorghum for sirup. A modified forage harvester, self-unloading wagon, trash-removal devices, and continuous processing plant are components. Further improvement is needed in trash removal. Rapid, continuous, automatic removal of solids from the juice during processing has not been achieved (Extramural - Blacksburg, VA).

From TO 1 - NRP 20170.

Sugarbeet

CO₂ exchange rate following 11 to 14 hours of illumination remained relatively constant while that of soybean declined significantly (Beltsville, MD).

Sugarbeet populations have been identified that differ in partitioning of photosynthate. Two cycles of selection altered the proportion of taproot-hypocotyl to leaf blade weight of two groups of sugarbeet progenies by 65 percent 21 days after emergence of the seedlings. This indicates that partitioning of photosynthate in sugarbeet has a strong genetic component. The differential was detectable 15 days after emergence (Beltsville, MD).

NRP Annual Report
FY 1976

NRP 20100 Breeding and Production--Forage Crops for Hay Pastures and
Other Uses, Including Turf

NPS Contact: R. F. Barnes

PACS Contact: L. L. Jansen

MISSION: This ARS-NRP outlines a research program on crop production efficiency to develop new knowledge and to increase crop and livestock productivity. Forage crops for hay, pasture, silage, and other uses, including turf and grass and legume seed production represent a resource of major economic significance in the United States.

TO 1 New and improved genetic populations, breeding lines, and cultivars of forage crops with improved yield, special use characteristics, quality, pest resistance, and tolerance to environmental stress.

TO 2 New and improved cultural and management practices that increase forage crop yields, minimize production and utilization losses, improve feed quality, conserve and use scarce resources efficiently, and enhance environmental quality.

TO 3 New and improved cultural and management practices that increase forage crop and turfgrass seed yield, reduce production losses, and improve seed quality.

TO 4 Turfgrass cultivars and genetic populations with increased pest resistance, tolerance to environmental stress, and improved agronomic characteristics.

TO 5 Improved cultural and management practices for turfgrasses that reduce the costs of maintenance, increase ground cover value, provide greater persistence, and improve aesthetics.

SELECTED EXAMPLES OF PROGRESS:

These examples are assembled by individual Technological Objectives. Within TO's 1, 2, and 3, the general order is legumes (alfalfa, clover, other legumes) followed by grasses (cool season, warm season, annual grasses).

TO 1 New and improved genetic populations, breeding lines, and cultivars of forage crops with improved yield, special use characteristics, quality, pest resistance, and tolerance to environmental stress.

Legumes

A new genetic model for the analysis of nonpanmictic autotetraploid populations was developed. Application of this model revealed that additive and digenic genetic effects were responsible for more than half of the genetic variation among populations derived from individual alfalfa clones. (University Park, PA)

Initial steps in testing a new breeding procedure were completed with the production of Syn 4 seed of seven alfalfa populations developed from crosses among eight alfalfa strains with high levels of resistance to various pests. This new procedure is designed to capitalize on complementation of dominant genes for disease and insect resistance contributed by the parent strains during the seed increase phase. Types of resistance include: bacterial wilt, common leafspot, anthracnose, rust, stem nematode, pea aphid, spotted alfalfa aphid, potato leafhopper yellowing, and alfalfa weevil larval feeding. Evaluations of the levels of resistance to these various pests are presently underway. (Reno, NV, Prosser, WA, Manhattan, KS, St. Paul, MN, University Park, PA, and Beltsville, MD)

An analysis of the genetic vulnerability of alfalfa in the United States was made. A history of parental germplasm used in cultivar development was prepared. It was concluded that because of the number of cultivars and the genetic diversity in the cultivars, alfalfa was generally less vulnerable to a genetic disaster than 50 years ago. However, it was evident that changes need to be made in the utilization of new germplasm if future vulnerability risks are to remain minimal. Concern must also be given to breeding methods that will maximize yield gains that can be achieved from heterosis. A national plan for utilizing and preserving existing and new germplasm was developed. A publication on the subject is being completed. (St. Paul, MN)

The entire M. sativa and M. falcata plant introduction collection (925 entries) was obtained from Ames, Iowa, and seeded in our nursery. This nursery should provide the basis for development of new alfalfa populations from previously little-used sources. (Beltsville, MD)

Completed study on inheritance of black seed color in alfalfa in cooperation with Minnesota. Character controlled by three genes each controlling a single pigment but inherited as a unit. Pigment appears to be anthocyanin not found in normal seed. The proposed use of this trait is as a removable marker in production of alfalfa hybrids. Preliminary analysis indicated two possibilities for separation, one by color sorting and the other by conventional size separation. (Reno, NV)

A third cycle of selection in alfalfa was completed for tolerance to toxic levels of aluminum in nutrient culture at pH 4.5. Preliminary evaluations indicate significant improvement in aluminum tolerance has been achieved. (Cooperative with NRP 20780) (Beltsville, MD)

Greenhouse studies were conducted to provide the basis for selecting alfalfas with improved nitrogen fixation potential. Alfalfa clones varied significantly for levels of nitrogen fixation as measured with the acetylene reduction procedure. Acetylene reduction levels were significantly greater in progenies from crosses between clones selected as high N₂ fixers than from crosses between clones selected as low N₂ fixers. Low by high crosses were intermediate. (St. Paul, MN)

Genetic variability has been demonstrated in the concentration of key mineral elements in alfalfa. These results provide the basis for a plant breeding program to improve the quality of forage crops through the correction of mineral deficiencies and improve the mineral nutrient balance. (University Park, PA)

A technical bulletin was published on the forage yield and quality of four alfalfa varieties that differed in level of resistance to potato leafhopper yellowing. First year forage yield and quality and other data were obtained on four varieties, that differed in resistance to specific insects, seeded in field plots that involved three insecticides and an untreated control. Comparable first year data were obtained too on four varieties, two with a low to moderate level of resistance to alfalfa weevil and two susceptible to alfalfa weevil, seeded in field plots, with and without insecticide in two cutting schedules. Comparable first-year data were also obtained on an integrated alfalfa pest management study that involves four varieties, resistant or susceptible to specific diseases and insects, in seeded field plots, and involves fungicide and insecticide treatments. (Lincoln, NE)

Differences among field cages infested with potato leafhoppers at 3 levels, 20, 40, and 60 adults/square yard, were obtained for protein and digestible dry matter contents for 3 years and for carotene content and yield in 2 or 3 years. Variety differences were obtained in 3 years for protein, carotene, and fiber contents, and forage yield, and in 2 of 3 years for DDM. Insecticide control of leafhoppers increased average protein content 21 percent, carotene content 83 percent, and forage yield 20 percent in individual cages. (Lincoln, NE)

In small cages, 15 and 27 percent decreases in forage yield and plant height, respectively, occurred in progenies subjected to alfalfa plant bugs at the rate of 2 bugs/cage. Differences in stunting among progenies at an infestation rate of 2 bugs/cage were not observed at 6 bugs/cage. (Lincoln, NE)

The evaluation of 419 accessions of 32 annual Medicago species and 187 accessions of 30 perennial Medicago species was completed for alfalfa weevil larval feeding. Several accessions of two annual species, M. scutellata and M. rugosa, were found to be consistently low for

larval survival after 8 days. Attempts are being made to produce interspecific hybrids between the two species and M. sativa. (Beltsville, MD)

In an evaluation of all available sources of potential resistance to the alfalfa weevil, a germplasm source selected from adapted stock in North Carolina was the only source of resistance (tolerance). This resistance was developed by recurrent generations of field selection. (Raleigh, NC)

Alfalfa plants with apparent resistance to weevil larval feeding were selected under natural infestation in the field. Plants with apparent resistance to feeding of adult weevils were selected under controlled conditions in the laboratory. (Manhattan, KS)

Intracross progenies from plants selected for resistance to weevil in the field, showed higher resistance to weevil larval feeding, higher forage yields, earlier spring growth, faster recovery after cutting and less fall dormancy than the parent variety from which they were selected. The parent varieties were Buffalo, Cody, Kansas Common, and Kanza. (Manhattan, KS)

The relationship of foliar feeding by insects with an increase in root rot development was established. More severe root rot, caused by Fusarium roseum, occurred when plants were under stress of pea aphid feeding. The interaction of potato leafhopper feeding with Fusarium root rot and winter conditions in reducing stand density was demonstrated in the field. The role of Phytophthora root rot in stand decline of alfalfa in Pennsylvania was established. (University Park, PA)

Phytophthora root rot (Phytophthora megasperma) of alfalfa has now been identified in five North Carolina counties extending from the Coastal Plain to the mountains. Greenhouse experiments with 5 alfalfa cultivars and 6 P. megasperma isolates, confirms statistically significant variations in virulence between isolates. A highly significant interaction between cultivars and isolates suggests further experiments to determine if races exist. Genetic studies of phytophthora resistance indicate moderate heritability and a moderate probability that resistant cultivars can be developed through phenotypic selection in the greenhouse. Initial selections have been made in three populations. (Raleigh, NC)

Bacterial wilt resistance is being incorporated into southern-adapted germplasm by wintertime selection in the greenhouse. Such selection appears to have resulted in a high level of resistance in three populations. (Raleigh, NC)

A study was conducted to determine if it would be feasible to simultaneously inoculate alfalfa plants with both Fusarium wilt and bacterial wilt

(Corynebacterium insidiosum (McCull) H. L. Jens.). Comparisons of plants inoculated with each pathogen alone and in combination indicated that C. insidiosum had no effect on the severity of F. oxysporum. However, F. oxysporum appeared to suppress the severity of bacterial wilt in the mixture. (St. Paul, MN)

A virulent Fusarium oxysporum isolate was obtained from a 3-year-old stand of alfalfa. This isolate killed virtually 100 percent of inoculated plants in several experimental lines in less than 1 month after inoculation. In view of the variable nature of virulence in Fusarium, this is being further investigated. (Prosser, WA)

A method was developed for evaluating alfalfas for reaction to Fusarium wilt (Fusarium oxysporum f. sp. medicaginis) in the field. Plants of 81 cultivars and experimental lines were evaluated to determine existing genetic variation for resistance. Disease severity was rated on a 0 to 5 scale with 0 = healthy plant and 5 = dead plant. The average severity ratings of entries ranged from 1.43 to 4.78. Cultivars adapted to the Southwestern United States had the greatest resistance. Cultivars adapted to the Northeast, Midwest, and Northwest were generally susceptible. (St. Paul, MN)

Crown rot is a serious problem on alfalfa throughout North America. A complex of fungi have been associated with it. No thorough search has been made for sources of host plant resistance. We surveyed the extent of crown rot in 3- and 4-year-old replicated broadcast stands of 32 alfalfa cultivars and more than 100 cultivars in replicated 3-year-old space-planted tests. All cultivars were injured by crown rot. The fungi most commonly isolated near the necrotic plant tissues were: Phoma medicaginis Malbr. & Roum., Fusarium solani (Mart.) Appel & Wr., and Rhizoctonia solani, Kuehn. Only small differences in crown rot severity were observed among cultivars. Winterhardy cultivars generally had less crown rot than moderately hardy cultivars. The frequency of disease-free plants was less than 0.2 percent of the plants evaluated. Progenies from crosses among crown rot-free plants had significantly less crown rot than most available cultivars. This suggests that it may be possible to select resistant varieties. Studies are underway to determine the association of crown morphology and field traffic to crown rot. (St. Paul, MN)

Identified Phoma medicaginis and Sclerotinia trifoliorum as pathogens causing severe damage to third harvest alfalfa in Reno area. Although rare in Nevada these diseases are common in most of the alfalfa growing areas. (Reno, NV)

A unique leafspot trait similar to potassium deficiency symptoms was studied on alfalfa. Expression of the trait was dependent on temperature. Leaves developed at 17° C. were spotted; whereas, leaves developed at 30° C. were normal. Genetic analysis of the trait indicated that it was controlled by two tetrasomic genes with random chromosome inheritance. (St. Paul, MN)

Previous research has indicated that about a 20 percent annual loss in alfalfa yield occurs from foliar diseases in the Minnesota-Wisconsin area. Studies are being conducted to determine if these losses can be reduced by limited applications of systemic fungicides. (St. Paul, MN)

Forage yield of plots artificially inoculated with alfalfa mosaic virus was significantly less than that of uninoculated checks. The reduction was approximately 10 percent, but since the uninoculated checks were not maintained in a virus-free condition for the whole season, the full effect of the virus on forage yield is not known. (Prosser, WA)

Studies of the combined effects of Fusarium sp. and Meloidogyne hapla indicated no reduction in plant dry-matter but an increase in root lesions in M. hapla susceptible lines infected with both organisms. The implication is that M. hapla resistance may reduce root deterioration from soilborne pathogens such as Fusarium. (Reno, NV)

Forage yield data for alfalfa in the Yakima Valley and the Columbia Basin indicate that Flemish-type alfalfas produce the most hay in short term stands except in locations where stem nematodes are a serious problem. Long term stands require a more winter-hardy alfalfa with bacterial wilt and stem nematode resistance. (Prosser, WA)

Completed selection in a non-hardy alfalfa experimental synthetic variety Syn YY highly resistant to Meloidogyne hapla, M. incognita and M. Javanica. Reduced M. hapla galling (but not absence of galls) in alfalfa responded to selection as a highly heritable character. Completed second cycle of phenotypic selection in one cultivar. Mini-plots heavily infested with M. hapla and seeded to alfalfa with 100, 70, 50, 30, and 0 percent M. hapla resistant plants showed that only the 100 percent resistant alfalfa gave sufficient control of the nematode population to be of practical value. The reduction of nema numbers under completely resistant alfalfa is very rapid. (Reno, NV)

A significant increase in rust resistance in red clover was achieved after two cycles of recurrent selection for resistance. The population is also resistant to northern anthracnose and mildew. After three cycles of recurrent selection for stemphylium resistance the percent susceptible plants were reduced from 80 to 39 percent (Base = 80 percent, SNAC1 = 67 percent, SNAC2 = 53 percent, SNAC3 = 39 percent). Resistance to red clover vein mosaic virus was determined to be controlled by a single dominant factor. Tissue culture investigations established an optimum media for the production of callus tissue from hypocotyl, ovary, and primordial red clover tissue. Significant yield differences between red clover hybrids were observed at two locations. (Range at Marshfield: 3.94 to 4.96 T DM/A: Adapt var = 4.81. Range at Madison: 2.45 to 4.72 T DM/A: Adapt. var = 4.85). Red clover yield trials were conducted at Arlington, Marshfield, Ashland, and Spooner. Arlington and Lakeland were among top varieties tested. Advanced generation seed was obtained from each of 15 red clover hybrids. No differences in first year red clover herbage yields were detected when 112, 224, 336, 448, 560, 672, and 896 kg/ha of K were applied. Yields tended to decrease at high

levels of KCl and application of K was beneficial to winter survival and second year yields. (Madison, WI)

Many isolates of Fusarium roseum, F. Moniliforme, F. oxysporum, and other species of Fusarium were characterized for pathogenicity and virulence on red clover, using the slant-board plant culture system developed last year. Two highly virulent isolates of F. roseum that differed in their mode of pathogenicity on red clover, were chosen for use in attempts to select host plant resistance. In the greenhouse, plants resistant to either of these isolates were selected from Kenland and Pennscott cultivars, as well as from lines selected for field persistence in 1959. Selection for field persistence seemed to have improved resistance to one of the test isolates, but not to the other. Red clover was more susceptible than alfalfa, but less susceptible than Ladino clover to attack by Fusarium spp. (University Park, PA)

Improving persistence of white clover depends primarily on finding resistance to virus and fungus diseases and, possibly, resistance to insect pests. Two clones, obtained from old pastures in North Carolina, have shown significant levels of tolerance to both virus and crown disease. Two others appear to have levels of tolerance that may be useful in varietal development. Progenies of the four clones have shown reduced levels of virus disease in tests over a 2-year period. (Raleigh, NC)

Data obtained in the summer and fall of 1975 from spaced plants in a phenotypic adaptation study indicated a close association between infection with peanut stunt virus (PSV) and decline of white clover plants. Incidence of PSV infection among plants severely weakened by decline was almost 100 percent; whereas, PSV infection was low among vigorous plants. This indicated importance of PSV, plus other data and observations caused us to start an extensive screening program to identify resistance to PSV. We plan to expand the program to include Clover Yellow Vein Virus (CYVV) and Alfalfa Mosaic Virus (AMV). (Clemson, SC)

Emphasis on screening for resistance to PSV was started in November 1975. The program is designed to identify resistance in young plants through a series of steps consisting of four mechanical inoculations, two aphid inoculations, and exposure in a field where PSV is prevalent. Plants are assayed, using cowpeas as the indicator host, after the mechanical inoculations, after the aphid inoculations, and after exposure in the field. Susceptibles are discarded. At present the program includes the survivors from over 2,000 seedling plants. The survivors are at various steps of the screening process. (Clemson, SC)

A species of white clover rust new to Virginia was identified as Uromyces nerviphilus. It was found at three locations, but extent of economic

losses are still being assessed. The value of an insecticide and fungicide together and singly in seeding white clover in established tall fescue sod is being studied under two managements. Over 200 clones of white clover selected for tolerance to acid soils were tested under two lime levels, but dry weather limited response to lime. (Blacksburg VA)

Techniques have been developed for use in screening crimson clover for resistance to the head weevil Hypera meleus Fab. Resistance to the head weevil should provide more reliable reseeding of crimson clover and reduce the requirement for chemical control of this insect. (Mississippi State, MS)

A serious disease complex has destroyed breeding nurseries of arrowleaf clover (Trifolium vesiculosum Savi.) for 3 years. The diseases are bean yellow mosaic (BYMV), clover yellow vein (CYVV), and peanut stunt (PSV) viruses; Fusarium spp.; and Pythium spp. The disease complex is believed to be associated with the presence of one or more insects. (Mississippi State, MS)

From 260 subterranean clover (Trifolium subterraneum L.) accessions of Australian origin, 50 were selected and placed under advanced testing. Sixty-eight newer accessions that were collected from Morocco, Tunisia, Spain, and Portugal in 1973 were evaluated in another test. Both groups of accessions were evaluated for resistance to powdery mildew (Erysiphe sp.). High levels of mildew resistance and variability were found among accessions. Mt. Barker and Woogenellup were determined to be the best of 13 Australian commercial cultivars evaluated for immediate use on acid, sandy, soils of the Coastal Plain. (Tifton, GA)

Hyacinth bean (Dolichos lablab L.) elite lines from the cross Rongai X Tifton accession 67-13 were subjected to their final screening for those combining the daylength-neutral and abundant seed production characters of 67-13 and the maximum increment of the greater forage productivity of Rongai. After seed increase, and further regional tests, they will be released as the first improved variety adapted to the U.S.A. for use as summer annual nitrogenous forage and/or green manure. (Tifton, GA)

Some of the wild yellow-flowered serradella (Ornithopus compressus L.) ecotypes collected in Morocco and Tunisia in 1973 appeared productive, disease and insect free, and well adapted as reseeding winter annual forage legumes on acid sandy soils. (Tifton, GA)

Blue lupine (Lupinus angustifolius L.) elite lines from Uniharvest X Rancher received final tests and seed increase and will soon be registered as improved germplasm in U.S.A. and Western Australia. Severe winter-killing conditions on blue lupine in 1975-76 at Tifton and Experiment, GA, allowed final selection for winter-injury resistance among F₅ elite lines

of 65G-251 X Uniharvest. This is the final step before seed increase and release in the United States and Western Australia of the first winter hardy, highly seed-shatter-resistant, disease-resistant, nitrogenous forage, green manure, and high-protein, feed-grain cultivar in the world. (Coop. J. S. Gladstones, Western Australia Department of Agriculture) (Tifton, GA)

Tests conducted with birdsfoot trefoil on several problem sites in the Champlain Valley verified that while most root rots are the direct cause of trefoil stand losses, various environmental factors predispose roots to damage by soilborne organisms. High nematode populations were found in association with the root-rot lesions of nearly all trefoil plants dug at one problem site in the fall of 1975, in the spring of 1976. Plant vigor was improved by phosphorous fertilization. Trefoil varieties differed in their ability to persist when soil pH, fertility, and drainage were suboptimal. Genotypes inherently low in vegetative vigor tended to be lost rapidly under those conditions. Recurrent selection for vigor was initiated in populations of Empire and Viking with the goal of improving their longevity. (Ithaca, NY)

Grasses

Investigations of the basic nature of apomictic mechanisms have provided valuable new information on one of the major barriers to forage grass improvement. These studies revealed an important difference in the cytological and genetic basis for reproduction in obligate and facultative apomicts. In obligate apospory activation of somatic nucellar cells to produce unreduced embryo sacs is accompanied by simultaneous suppression of the sexual mechanism. Since obligate apomixis is genetically controlled, it is possible to manipulate and control method of reproduction through hybridization when sexual plants are available for use as female parents. This technique has been used effectively in the improvement of apomictic buffelgrass. Our results show that facultative aposporous apomicts lack the capacity for destruction of the sexual mechanism and pose entirely different problems in plant breeding. Control of facultative apomixis will require genetic or biological suppression of the sexual apparatus. Potential use of genetic female sterility, radiation and triploidy are being investigated. Lack of sexual plants of apomictic species and limited germplasm have hindered improvement of perennial grasses for the arid Southwest. In 1976 a successful plant exploration was conducted in the Republic of South Africa and acquired some 1,300 grass accessions. These included promising germplasm of Cenchrus, Eragrostis, Panicum, and other genera native to arid environment. (College Station, TX)

Studies have continued to define morphological and anatomical traits in forage grasses with a view of selecting individual plants for improved rumen fluid penetration and increased rate of digestion. Cultivars of

major species were established and leaf-sampled for screening. Many experimental techniques have been attempted to develop reliable samples for estimating a plant genetic expression of the leaf penetration phenomenon. Barley has been used as test organism in the application of techniques. Presently, the masking tape technique of sealing both ends of leaves is the most workable. Additional forages, especially tall fescue, have been planted for these studies. (Beltsville, MD)

Lolium and Festuca hybridization is being utilized to develop populations at the $2n=42$, 56, and 84 chromosome levels in an effort to improve tall fescue for disease resistance, forage quality and tolerance to environmental stress. Selected hybrids ($2n=42$) were found to vary significantly in content of K, Ca, and Mg and had "broad sense" heritability estimates of 0.62, 0.57, and 0.20 for percent moisture of green weight, digestibility, and total sugars, respectively, indicating that progress is possible in breeding for improved quality. A 31-clone hybrid ($2n=42$) synthetic was higher in percent crude protein, ether extract, and digestibility; and, lower in acid detergent fiber and lignin, but equal in yield to Ky. 31 tall fescue. (Lexington, KY)

Colchicine-induced amphiploid progenies ($2n=84$) of tall X giant fescue hybrids ($2n=42$) were male fertile, and seed-set per panicle was equivalent to that of tall fescue. The occurrence of dodecaploids as the most frequent member in the fourth-generation progenies indicates that with rigid selection, rapid progress could be made in securing meiotically stable populations at the $2n=84$ chromosome level. Forage quality of these progenies was markedly superior to that of tall fescue. Thus, the dodecaploid populations appear to have promise as a valuable forage crop. (Lexington, KY)

A forage test established in 1974 includes 17 bluegrass entries (11 of them experimental selections) and 9 red fescues (4 experimental sels.) in broadcast plots. Harvested 4 times in 1975, forage dry-matter yields of 4 experimental bluegrasses surpassed 4 T/A, more than twice the yields of the taller growing Polar brome and Engmo timothy, included as checks, that are less tolerant of frequent harvest. Identification of highly productive, extremely winterhardy bluegrasses (these are indifferent to frequent cutting) opens another option to forage producers in the Subarctic where Kentucky bluegrasses do not go "summer-dormant" as in mid-temperate latitudes. (Palmer, AK)

After 20 harvest years in 4 large field experiments (harvested twice annually), top forage yielders were Nugget Kentucky bluegrass and Arctared red fescue, followed closely by Garrison creeping foxtail, Polar brome grass, and 2 native Alaskan grasses, arctic wheatgrass (Agropyron macrourum), and arctic brome grass (Bromus pumpellianus). The impressive performance of the Kentucky bluegrass and red fescue reveals that these short-type species, despite limited utility in

hotter mid-temperate latitudes, hold considerable promise as forage producers in the Subarctic. The native wheatgrass and brome grass represent relatively unselected bulk lots, and suggest that artificial selection within these species for still better forage production and other desirable agronomic characteristics, should be worthwhile. (Palmer, AK)

Conclusion of a 3-year field-plot test with emphasis on wildryes (Elymus spp.) revealed low forage yields, deficient winterhardiness, and poor persistence in non-Alaska wildryes. These included Russian wildrye (E. junceus), Canada wildrye (E. canadensis), basin wildrye (E. cinereus), Volga wildrye (E. giganteus), and alтай wildrye (E. angustus). Native Alaskan E. sibiricus and E. mollis persisted best and the former ranked with other non-Elymus entries until the 1975 season when thinning stand caused it to be surpassed by Polar brome grass, Garrison creeping foxtail, 3 timothies, and native Alaskan arctic wheatgrass and arctic brome grass. (Palmer, AK)

Space-planted evaluation nurseries of intermediate wheatgrass, switchgrass, the tall bluestems, and smooth brome grass were established to determine which varieties and experimental strains have the best potential for use in a population improvement breeding program using recurrent selections. (Lincoln, NE)

Three potential breeder seed fields of Prairie sandreed, Calamovilfa longifolia, have been established. Prairie sandreed is one of the dominant grasses in the sandhills of Nebraska. A named variety of this species is needed for range reseeding. (Lincoln, NE)

Selected plants of 'Oto' indiagrass and the 'ff' and 'ey' strains of switchgrass, established in 1973, were assayed for IVDMD and crude protein in 1974 and 1975. Although r values between the 2 years were generally highly significant, many of the values were no greater than 0.5, indicating that values obtained in 1 year are not highly reliable predictors of values for the following year. (Lincoln, NE)

The recurrent restricted phenotypic selection (RRPS) plant breeding technique has been modified to permit one cycle of selection per year instead of one cycle every 2 years. RRPS was used to increase Pensacola bahiagrass forage yields 17.7 percent over the check in four cycles. Application of the technique to tetraploid bahiagrass showed promise in 1975. (Tifton, GA)

Histological studies of 1- and 4-week-old stems and leaves from high and low digestible bermudagrass lines showed that lignified areas more than doubled in 1- to 4-week-old stems; whereas, there was only a slight increase in this area in the leaves. This indicates that

the major reduction in bermudagrass forage quality with age occurs in the stem. No anatomical differences were observed between high and low quality bermudagrasses of a comparable age. (Tifton, GA)

Tifton 44, an F₁ hybrid between Coastal bermudagrass and the winter hardy plant found in Berlin has survived the winters in the Midland bermudagrass belt. It yields as well or better than Midland, is more disease resistant, and has a significantly higher in vitro dry matter disappearance. (Tifton, GA)

The digitgrass cultivars 'Pangola' and 'Transvala' differed in response to varied rhizosphere oxygen levels. Mineral uptake and growth rates of pangola were not depressed appreciably by >20 days' exposure to solutions having oxygen concentrations of 100 to 125 μ l/l. This restricted oxygen supply produced acute distress in Transvala plants. The adverse effects of sustained low rhizosphere oxygen conditions were exacerbated by inadequate nutrient supply. Pangola was superior to Transvala in capability to survive under regimes which combined several stress influences. (Gainesville, FL)

Repeated inoculations of the rhizosphere with the nitrogen-fixing bacterium Spirillum lipoferum, under low nitrogen but otherwise adequate nutrient conditions, increased dry matter production of both cultivars in some tests. However, tests with various inoculation methods and growth regimes have revealed none which insures a consistent favorable response to bacterial treatments. (Gainesville, FL)

A procedure for assessing the hydrocyanic acid potential of sudangrass and sorghum, based on the determination of p-hydroxybenzaldehyde (p-HB), which is released upon hydrolysis of dhurrin, was developed. Extraction and hydrolysis of dhurrin are accomplished by autoclaving young leaf tissue in water. The content of p-HB in the aqueous extract is then determined by spectrophotometric assay in alkaline solution at 330 nm. Uniform samples for the comparison of widely divergent genotypes are obtained by using the first leaf of young, chamber-grown, green seedlings. (Lincoln, NE)

Bloomless sorghum has significantly higher net carbon dioxide exchange (NCE) and transpiration rates than sorghum with the waxy bloom. The bloom and associated cuticle characteristic acts as a barrier that modifies gas exchange properties. Under adequate moisture, maximum digestible dry matter may be obtained from bloomless sorghum because of their higher NCE rates. (Tifton, GA)

Although pearl millet is protogynous and might seem to be 100 percent cross-pollinated, we observed 18 and 31 percent of selfing in two consecutive years. Factors affecting pollen movement and natural

crossing include wind velocity, wind direction, height of pollen shedder, distance, number of culms per plant, and time of day when pollen is shed. In three near isogenic F_2 populations of pearl millet, average yield increased and average quality (IVDMD) decreased with age. One increased age without a loss in quality. Variation in all four populations suggested that high-yielding, late-maturing plants with high IVDMD could be selected. Average daily gains of nine heifers grazing Gahi 1, Gahi 3, and Tifleaf 1 pearl millet in 1975 were 1.04, 1.61, and 1.85 pounds, respectively. Seed production of Gahi 3 under irrigation in Arizona has been successful. An effort to improve the quality (IVDMD) and performance of pearl millet by recurrent, restricted, phenotypic selection (RRPS) population improvement was begun in 1975. (Tifton, GA)

Spontaneous haploid occurrence in pearl millet was 1 per 10,000 plants in 'Tift 23A.' Seed set ranged from 0 to 502 seed per plant. Cytological and reproduction studies indicate that haploids are amenable to breeding techniques such as monoploid derived inbreds. (Tifton, GA)

The role of internally seedborne inoculum in epiphytology of downy mildew of pearl millet has been confirmed. Oospores play a significant role in epiphytology and while maximum survival time of 6 years has been observed, good survival up to 18 months is common. Detailed histopathology has followed the disease cycle from infection through both the seedborne path of the disease cycle with live mycelium surviving in the embryo, secondary spread by oospores; and the development, survival germination of oospores, and oospore infection of the seedlings. Some evidence exists which indicate physiological specialization of Sclerospora graminicola. Techniques have been developed for maintaining the downy mildew on callus tissue cultures. Techniques have been developed for screening for downy mildew resistance of seedlings in the laboratory and in mildew "sick-plots" in the field. (Tifton, GA)

TO 2 New and improved cultural and management practices that increase forage crop yields, minimize production and utilization losses, improve feed quality, conserve and use scarce resources efficiently, and enhance environmental quality.

A laboratory method based upon measurement of the reflectance of specific wavelengths of infrared light to determine chemical components of a small ground forage sample has been developed. A 32K, PDP 11/T10 computer system with nine track magnetic tape and hard copy decwriter has been placed into operation. The multiple wavelength selection program was modified so that wavelengths added to the equation were selected on a statistical basis. Spectral data were obtained for 38 forage-concentrate diets. Equations were developed to predict protein, neutral detergent fiber, acid detergent fiber (ADF), lignin, hemicellulose,

cellulose (C), density (D), and in vitro digestions R^2 values ranged from 0.98 for ADF, C, and D with standard errors (S.E.) of 1.1 percent, 0.9 percent, and 0.02 g/ml, respectively to an R^2 of 0.85 for protein and S.E. 0.90 percent. These diets were fed to weanling meadow voles and equations were obtained to predict weight gain ($R^2 = 0.86$), intake ($R^2 = 0.78$), and digestibility ($R^2 = 0.94$). To obtain evidence that other animal response criteria may be predicted by infrared reflectance (IRR), a sheep preference trial was conducted with 15 crownvetch clones in a replicated field plot trial. Forage samples were taken from each plot before grazing and dried and ground for IRR analyses. Sheep were allowed to graze the crownvetch plots for 48 hours after which clones were rated for preference on a 1 to 10 scale. IRR analysis of the forage samples indicated that sheep preference could be predicted for crownvetch with an R^2 of 0.87, S.E. = 0.47. (University Park, PA)

An alfalfa growth model that uses weather data to predict hay yields has been developed. Information provided by this growth model is being used by research and extension specialists for making management decisions and recommendations for fertility practices, insect control sprays, and time of harvest. The approach will be useful to farmers and is being adapted to pest management systems in the Midwest. (West Lafayette, IN)

Alfalfa plants have been identified via a 3-year field selection program that differs in yield and tolerance to frequent harvest. These materials provide a basis for a detailed characterization of yield components in alfalfa. Percentage of total nonstructural carbohydrate (TNC) in crowns and roots of high-yielding alfalfa plants at the end of the growing season are much higher than in low-yielding plants. Similarly, the percentage of TNC of crowns and roots tolerant to frequent harvest were higher than in intolerant plants. (Beltsville, MD)

A wide-leaved alfalfa clone permitted more light to penetrate the canopy than a narrow-leaved clone over a range of leaf area indexes. (Bozeman, MT)

Callus tissue cultures of alfalfa and jackbean hypocotyl tissues were established for the purpose of investigating the mechanism of phytoalexin biosynthesis. After treatment with 3.15 mM $HgCl_2$ or 10^7 Pithomyces chartarum spores/ml, callus tissues were shown to produce several compounds not detected in untreated tissues. Two compounds in alfalfa were found to be fungitoxic by a Cladisporium sp. bioassay. One of the compounds from jackbean was isolated and identified as medicarpin, a phytoalexin previously reported in alfalfa, jackbean, and red clover. Further studies are underway to better understand the synthesis of medicarpin in plants and the role it may have in disease resistance of plants. (University Park, PA)

Root mass, in year-old Vernal alfalfa, exhibited seasonal fluctuation. By early May, root weight had increased from 275 to 510 grams per square meter. A decrease in root mass followed, reaching pre-growth levels by early June. During the remainder of the growing season root mass showed a steady rate of increase, reaching 980 grams by late September. This response appeared to be primarily physiological in nature, modified by harvest and plant loss. (West Lafayette, IN)

Root grafting and bleeding experiments show that saponins move from the roots to the tops in alfalfa. Forage sampling and testing for saponin from May to November show that saponin is most concentrated in the foliage in the hottest part of the summer and is low in spring and fall. The above suggests that an accumulation of antiquality compounds cause the "date effect" in forage crop quality, explain the low quality of second crop alfalfa hay, and the depression in digestibility of grasses in midsummer. Thus, there are two quality cycles, the crop cycle and the season cycle, to consider when evaluating hay quality. Quality in the crop cycle is largely dependent upon protein and fiber content, but quality in the season cycle is dependent upon antiquality components such as saponins or alkaloids. (Logan, UT)

Fifteen percent low and high saponin alfalfa rations were fed to pigs together with a check which received no alfalfa. Results showed that the gains per day were 1.88, 1.66, and 1.36 for the control, low saponin and high saponin, respectively. In the same order pounds of feed per pound of gain were 2.86, 3.28, and 3.57. Saponin content of alfalfa used in pig rations appears to affect the nutritional value of the ration. (Logan, UT)

Preference trials with rats and rabbits showed that rats prefer rations composed of low saponin alfalfa meal over high saponin alfalfa meal when the alfalfa is 10 percent or more of the ration for rats and about 20 percent for rabbits. Apparently rats and rabbits respond to the bitter taste of high saponin alfalfa as do humans. (Logan, UT)

Forage yields of white clover and other Trifolium species grown on acid soils were increased greater than threefold by using specific inoculum cultures of nitrogen-fixing bacteria and applying small amounts of molybdenum. Other advantages were improved forage stands, earlier plant growth, and less weed competition. (Mississippi State, MS)

Systems involving the sequences of annual and perennial clovers indicates that grass-legume mixtures can be maintained for year-round production. The advantages of Regal and Tillman white clovers in providing grass-legume mixtures in the summer compared to common white clovers was demonstrated. (Mississippi State, MS)

At Mt. Vernon, MO, average daily gains of cattle were 16 percent higher and fertilizer costs were \$26 less/A where tall fescue was grown with

alfalfa and red clover as compared to tall fescue grown alone and fertilized with 125 lb N/A. Gain/A was 56 lb/A higher on the fescue fertilized with nitrogen; however, legumes were not fully established and into full production having been seeded into the fescue sod during the previous winter. (Columbia, MO)

Grazing studies were conducted with annual clovers and ryegrass. Average daily gain (lb/da) and gain (lb/A) were: Subterranean clover, 2.03 and 348; annual ryegrass, 1.68 and 330; arrowleaf clover, 2.54 and 492; and white clover, 2.32 and 485. (Tifton, GA)

Sixteen varieties and experimental strains and 100 accessions of subterranean clover, T. subterraneum L., have been evaluated at Mississippi State, Mississippi. Performance of five of the subterranean clover cultivars grown with ryegrass, fescue, and alone indicates considerable potential for this species in improving much of the grassland in the Southeast. Forage production of this species is approximately the same as for crimson clover and reseeding is assured through both hard seed and embryo dormancy. (Mississippi State, MS)

Subterranean clover (Trifolium subterraneum L.) was seeded on a virgin fuquay loamy sand soil with a pH of 4.9 and low levels of available P and K. Fertilizer treatments consisted of dolomitic limestone at 0, 2.24, 4.48, and 8.96 metric tons/hectare, phosphorus at 0, 56, 112, and 224 kg/ha, and potassium at 0, 112, 224, and 448 kg/ha. The entire plot area received 2.25 kg/ha of soluble boron. Yield response to lime was not significant. Dry matter yields significantly ($P < .05$) increased with increasing phosphorus levels. There was a consistent trend toward higher yields with increasing K levels. (Tifton, GA)

Two years' data from pasture systems for lambs revealed that systems including birdsfoot trefoil (BFT) give greater daily gain and greater lamb product per ha even though less carrying capacity. Average daily gains (g) for 1974: (I) alfalfa-brome-orchard mixture, 119; (II) alfalfa-orchard, alfalfa-reed canary, alfalfa-brome sequence, 118; (III) 2/3 as I and 1/3 as BFT in sequence, 147; (IV) 2/3 as I and 1/3 as BFT stockpiled, 141. Gains (g) for 1975: (I) 67; (II) 63; (III) 97; (IV) 90. Lamb product per ha (kg) for 1974: (I) 529; (II) 520; (III) 612; (IV) 586. For 1975: (I) 314; (II) 307; (III) 409; (IV) 384. Relative stand persistence of alfalfa and BFT remains to be measured. (St. Paul, MN)

Studies were completed on the isolation and identification of constituents in crownvetch (Coronilla varia) that adversely affected the growth and development of animals. Semi-purified compounds from crownvetch were separated into distinct fractions; and from these compounds, beta-nitropropionic acid (BNPA) was identified as the toxic constituent. BNPA was found to exist as esters of glucose. Five esters were identified and structures assigned. Two of the esters were previously identified

as cibarian in Astragalus and karakin in Astragalus and Corynocarpus. Three new esters were identified and named: corollin, coronillin, and coronarian. (University Park, PA)

A colorimetric procedure was developed to detect the presence of the alphatic nitro fraction of the esters. This procedure was used to quantify the concentration of BNPA in crownvetch seedlings, individual plants, hay, and haylage. Concentrations ranged from 0.2 to greater than 3 percent of the dry matter. Haylage field-cured forage exposed to weathering, or frosted forage harvested in the fall usually contained the lowest concentration of BNPA. (University Park, PA)

Feeding and metabolism trials, using crownvetch forage or BNPA, fed meadow voles, chicks, and pigs established that toxicity of crownvetch to nonruminants is correlated with BNPA content. It is recommended that crownvetch not be fed to nonruminant animals if the diet concentration of BNPA exceeds 0.05 percent. However, ruminant animals can be fed crownvetch forage safely because the esters of BNPA will be detoxified in the rumen before they enter the lower gastrointestinal tract. (University Park, PA)

Cyclic growth surges in brome grass make it an uneven forage source for green-chop operations; moreover, it is predisposed to winter injury if harvested frequently. A test harvested 4 times in 1975 evaluating bluegrasses and red fescues for intensive utilization resulted in four entries yielding over 4 tons dry matter/A. (Palmer, AK)

Regar brome grass (Bromus biebersteinii) continued to outyield Manchur brome grass (Bromus inermis) by approximately .4 ton/A in simulated pasture trials. (Bozeman, MT)

Termination of a 2-year dairy-cow grazing-preference study with seven perennial grasses revealed a clear preference for Polar brome grass, Engmo timothy, and Nugget Kentucky bluegrass over Arctared red fescue, Garrison creeping foxtail, and native Alaskan arctic wheatgrass and siberian wildrye under three and four pasturings/growing season. (Palmer, AK)

Timing of the first harvest had great influence on the botanical composition of mixtures of smooth brome grass and reed canarygrass: cutting at 30 cm, 33 percent brome; at 60 cm, 15 percent brome; at full head, 43 percent brome. Of eight perennial species, alfalfa and smooth brome grass persisted least well after treatment with high rates of municipal sewage effluent; tall fescue and reed canarygrass are yielding best. (St. Paul, MN)

Initial studies with 20 genotypes of reed canarygrass indicates that there are significant variations among genotypes in rate of photosynthesis

per unit leaf area, activity of ribulose 1,5-diphosphate carboxylase, specific leaf weight, and stomate frequency. The relationship, as determined by simple correlation, of these physiological parameters to forage yield of all 20 genotypes was small. Field measurements of physiological parameters are affected by such factors as temperature, radiation, water stress, and mineral nutrition which also have a major effect on photosynthesis by regulating stomatal behavior and the flow of gas in the leaf-atmosphere system. Although genotypes with higher rates of leaf photosynthesis are not always the high yielders, their incorporation into a germplasm pool perhaps would be beneficial. Genotypes that have higher rates of photosynthesis have the potential for greater yield, especially if selection criteria includes other characters that contribute to higher yield. (Mandan, ND)

Alkaloid concentration of reed canarygrass was negatively associated with daily gains of grazing steers. Average daily gains were as follows: high-gramine grass, 0.18 kg; low-gramine, 0.35 kg; high-tryptamine-carboline, 0.11 kg; low-tryptamine-carboline, 0.30 kg. Diarrhea incidence (D-I) in steers was high on all pastures in July. Low-alkaloid pastures in September had no D-I, while high-alkaloid pastures had 50 percent D-I. The biological significance of reed canarygrass alkaloids was shown for cattle as well as sheep. (St. Paul, MN)

A 28.8-acre pasture study (cooperative with University of Maryland) was initiated to evaluate production differences in tall fescue cultivars with characteristic differences in alkaloid content. Forage samples are being taken throughout the grazing period, before and after grazing, and are freeze-dried or oven-dried at 60° C. A rotational grazed, replicated, put-and-take system of grazing is being used. (Beltsville, MD)

In small-plot clipping trials, dry matter yields and in vitro dry matter digestibility (IVDMD) of 'Kenhy' (a Lolium-Festuca hybrid) and 'I-96' (a 14-clone synthetic) tall fescue have been equal to or less than 'Kentucky-31' tall fescue. In replicated grazing trials, daily gains of steers have averaged nearly 40 percent higher on 'Kenhy' and 'I-96' than on Kentucky-31.' Season-long ADG's have averaged 1.22 lb on 'Kenhy,' 1.17 lb on 'I-96' and 0.84 lb on 'Kentucky-31.' These data show the importance of animal evaluation of new cultivars and the weakness of depending only on small plot and laboratory data as a basis for releasing new cultivars. (Columbia, MO)

At Columbia, MO, beef cattle gains (ADG and Gain/A) have not been different on tall fescue continuously grazed vs. fescue grazed in a 'system' with one pasture for spring and fall grazing and a second pasture cut as hay, round baled, and the hay and regrowth grazed during the "summer slump" and again in late autumn. Only in the system did increased rates of stocking (1, 1.5, and 2.0 head/A) result in lower cattle daily gains. Over the past 2 years, cattle ADG's at Columbia have averaged nearly 100 percent lower than cattle gains at Mt. Vernon

on the same fescue system. This suggests a strong plant X soil X animal X environment interaction for animal performance on tall fescue. These results are similar to varied levels of animal performance reported from tall fescue throughout the Southern Corn Belt. Future research effort should be directed to defining the reason for highly variable animal performance on tall fescue among locations. (Columbia, MO)

The fourth year results from cow-calf evaluation of a fescue-Coast system fertilized at two rates of N (120 and 240 lbs N/acre) and three stocking rates continue quite satisfactory. Calves on the 120-lb rate gained 1.74, 1.40, and 1.09 lbs per day when stocked at 1.33, 1.67, and 2.11 cow-calf units/acre, respectively. The 240-lb rate gave calf daily gains of 1.51, 1.26, and 1.22 lbs when stocked at 1.61, 2.07, and 2.57 cow-calf units/acre. Calf gain per acre ranged from 377 to 584 lbs. First year results from a fescue-clover mixture grazed in sequence with coastal gave calf daily gains of 1.52 lbs and 448 lbs of calf/gain/acre when stocked at 1.79 cow-calf units/acre. (Raleigh, NC)

Yield tests of 140 forage sorghums cut at a silage stage ranged from 9.8 to 22.4 T/A at 30 percent DM. IVDMD ranged from 61.6 to 67.4 percent and crude protein from 5.4 to 8.6 percent. Ten sudangrasses cut three times during the season yielded from 4,706 to 7,504 lbs DM/A for the season. Crude protein of the sudans ranged from 11.8 to 14.2 percent. (Lincoln, NE)

TO 3 New and improved cultural and management practices that increase forage crop and turfgrass seed yield, reduce production losses, and improve seed quality.

A greenhouse alfalfa seed production study was conducted using sodium vapor, mercury vapor, and metal halide lighting in comparison with standard incandescent lighting. Results were proportional to the quantity of light produced by each light source. A fourfold increase in seed production was obtained with the sodium vapor lamps. (Beltsville, MD)

Kenland red clover, grown from certified seed, was less persistent and productive than clover grown from foundation or breeder seed, particularly if the certified seed had been increased in the lower latitudes of the Western United States. These certified lots contained a higher proportion of early flowering plant types. (West Lafayette, IN)

Dollard red clover seed stored at -15° C. since 1960 but placed in a warm room for 24 hours once each week (thawed 780 times) tested 91 percent by the standard seed germination test, 81 percent by the cold test, and 31 percent by the accelerated aging test. In comparison, seed from the same source stored continuously at -15° tested 97, 95, and 81 percent, respectively. (Prosser, WA)

The progenies of birdsfoot trefoil plants selected for high seed yield in crosses of hardy X non-hardy parents appear to be relatively winter-hardy. Composites representing three to five cycles of selection for winter survival in Kimmey (a vigorous, non-hardy source) X Viking crosses are being evaluated. (Ithaca, NY)

The second cycle of recurrent selection for seed size and seedling vigor in birdsfoot trefoil was completed. Seed size has increased from populations of "Leo" and "PI 4546" Trefoil with mean seed sizes of 132 and 105 mg/100 seed, respectively, to a new population with a mean seed size of 156 mg/100 seed. (Bozeman, MT)

Ten sainfoin accessions from three species did not differ in ability to distribute a unit of seed weight into cotyledon area. Large seed was associated with larger embryo axis, leaf primordia, and cotyledon area and with more rapid seedling development. (Bozeman, MT)

Seed vigor of 18 forage grass and legume cultivars stored at -10° C. since 1961 to 1964 was compared with that of genetically identical seed produced in 1975. The stored seed performed satisfactorily in standard germination and greenhouse emergence tests, but accelerated aging tests indicated that seed of only seven cultivars retained full vigor and that seed vigor of three cultivars was nil. (Prosser, WA)

Post-harvest burning of fields in 1974 gave good control of ergot, (Claviceps purpurea), blind seed disease (Gloeotinia temulenta), and grass seed nematode (Anguina agrostis) during 1975. Many brief high-temperature treatments applied with mobile field sanitizers in experimental plots were effective against these three major diseases. Several new chemicals prevented formation of ascocarps in C. purpurea and G. temulenta with the strongest activity provided by BAY MEB 6447. Chemotherapy of ergot and blind seed disease again was unsuccessful with several systemic chemicals. BAY MEB 6447 and BAS 31702 both gave excellent control of stripe rust (Puccinia striiformis). Stripe smut (Ustilago striiformis) and flag smut (Urocystis agropyri) were eradicated in Kentucky bluegrass (Poa pratensis) by root uptake of low dosages of BAY MEB 6447. (Corvallis, OR)

Several management methods were evaluated as alternatives to open burning of post-harvest residue of Kentucky bluegrass seed fields. High-temperature machine burning of residue after mechanical hay removal resulted in the highest yields. The 3-year average seed yields of Merion under sprinkler irrigation were higher following machine burning (651 kg/ha), compared with open burning (514 kg/ha) or mechanical removal (436 kg/ha) of residue. Under dryland conditions, there were no significant differences in the second seed crop of Merion as a result of residue management. However, in the third seed crop, machine burning resulted in higher seed yields (512 kg/ha), compared with open burning (332 kg/ha) or mechanical removal (292 kg/ha) of residue.

Established stands of Kentucky bluegrass, tall fescue, red fescue, orchardgrass, colonial bentgrass, and perennial ryegrass plots treated with various heat exposures by mobile field sanitizers survived and produced seed yields equal to open-burned plots. Some design modifications reduced weed and disease control because of too low temperature at the soil surface. This problem will require particular attention in the future as design changes are made to lengthen machine life. Close-clip removal of crop residues produced good yield results with some species, but increased mortality in orchardgrass. Satisfactory field operation will require that special equipment be designed. Continued study of species interaction with new sanitizers and close-clip equipment is needed as engineers attempt to design satisfactory equipment to develop new methods for field sanitation as substitutes for open burning to reduce air pollution. (Corvallis, OR)

A seed-production test evaluating management options with Nugget Kentucky bluegrass and Arctared red fescue was planted 28 May 1975. Three seeding rates (1, 2, 4 lb/A) at 4 row spacings (6, 12, 18, 24 inches apart), and 6 seeding rates (1, 2, 4, 8, 16, 32 lb/A) in broadcast plots, will be compared over several seed-harvest years beginning in 1976. (Palmer, AK)

Three bermudagrass clones that set seed well in small plots surrounded with other bermudagrasses set seed poorly in large plots. Self-incompatibility believed to be the cause should be overcome in a 1975 planting in which these three similar clones were interplanted. (Tifton, GA)

Studies with bermudagrass indicate that carefully planned field management practices are more essential for the production of high seed yields than are cultural (nitrogen). Seed yield measurements from the best management practice at the El Reno station were in excess of 650 kg/ha. Combine harvesting the seed from a cured swath and rethreshing the tailings twice resulted in a recovery of only 38 percent (250 kg/ha) of the harvestable seed crop. Analyses of the stover (straw) or tailings baled after seed harvest showed that a 55-pound bale contained 0.2 to 0.5 kg seed; a loss of 33 to 82 kg seed/ha. Seed-set, regardless of the field management practice and nitrogen rates used, averaged 72.8 percent. Differences in seed yield among management practices were attributed to significant differences in seedstalk numbers. Additional seed production evaluation blocks were established from seed (Syn-1) of two cross compatible paired bermudagrass strains at two locations in the State. (Stillwater, OK)

TO 4 Turfgrass cultivars and genetic populations with increased pest resistance, tolerance to environmental stress, and improved agronomic characteristics.

The first foreign plant exploration on tall fescue for turf was conducted in June-July 1975. Its purpose was to search out the native biotypes in geographical areas of its greatest diversity. More than 6,000 miles of roadsides and adjacent fields were explored in Portugal, Morocco, Spain, and France. The 350 biotypes of fescue will become assimilated in new and improved germplasm for turf. More than 100 accessions of other turfgrasses were also collected and are being propagated at the Beltsville Agricultural Research Center. (Beltsville, MD)

A technique to hybridize Kentucky bluegrass using air-filled polyethylene bags as isolation chambers and subsequently identifying hybrids in the greenhouse as seedlings, gave 93 percent precision of hybrid identification. Since most seed from Kentucky bluegrass is not of hybrid origin, this technique offers a major saving in space by transplanting only the hybrid plants. (Beltsville, MD)

Kenblue Kentucky bluegrass when evaluated for turf was superior to approximately 20 other selections and varieties for sod webworm tolerance, density and turf quality; and, Nuggett was poorest. Vantage had best and Nuggett had poorest color of the bluegrass varieties. Kenwell and Kenhy had best and Penngreen had poorest color of the tall fescue varieties. Polycross progenies of two tall fescue selections from the Kenwell variety had best turf quality (general turf performance). Tall fescue was not injured by sod webworm and, generally, performed better during periods of environmental stress under turf management than Kentucky bluegrass. (Lexington, KY)

A forage test (4 cuts/yr) involving 17 bluegrass entires (11 of them experimental selections) and 9 red fescues (4 experimental sels.) in broadcast plots identified one extraordinarily early bluegrass that also possesses outstanding winterhardiness. Seed is being increased to evaluate turf quality of this selection under lawn-type management. Extremely winterhardy bluegrasses, especially Nugget, typically exhibit tardy growth initiation with slow greening in spring, a characteristic considered undesirable for best turf purposes. (Palmer, AK)

We have determined that Helminthosporium sativum is primarily responsible for the rapid decline of red fescue in hot, humid environments of the transition zone. We have developed procedures to screen red fescue populations for resistance or tolerance to this pathogen. Resistant, and some susceptible clones, have been isolated, which in repeated inoculations, consistently demonstrate, respectively, either their resistant or susceptible reactions. Screening of vegetatively propagated clones has begun. Results to date indicate progress could be made in developing an H. sativum-resistant red fescue. (Beltsville, MD)

The evaluation of 158 bermudagrass mutants (created by exposing dormant rhizomes of Tifgreen, Tifdwarf, and Tifway to 7,000 to 9,000 rads of

gamma rays) was continued in 1975. Some that showed promise early in the testing period appeared to be inferior in 1975. Six of the best mutants and their three parents (Tifway, Tifgreen, and Tifdwarf) were evaluated for nematode resistance in the laboratory. (Tifton, GA)

The mutation breeding methodology was successfully applied to St. Augustinegrass and 13 new types were selected. The variety 'Floritam' is a SAD (St. Augustine Decline) virus-resistant and chinchbug-resistant selection needing further breeding improvement for winter hardiness. The new mutants from Floritam are being tested for winter hardiness and retested for retention of SAD virus and chinchbug resistance. (Cooperative with Dr. Robert Toler of Texas A. & M. University.) (Beltsville, MD)

TO 5 Improved cultural and management practices for turfgrasses that reduce the costs of maintenance, increase ground cover value, provide greater persistence, and improve aesthetics.

Performance data were obtained on 80 Kentucky bluegrass varieties and blends and 37 fineleaf fescues in the Northeastern Regional Tests seeded in 1972. Adelphi, Brunswick, Parade, Majestic, Windsor, Merion, and Adelphi + Nugget had the highest yearly ratings for turf quality when mowed at 2-1/2 inches, not irrigated, and receiving 2 to 3 lb N/M/yr. Nugget, Merion, Fylking, Glade, and Touchdown produced the highest quality turf when mowed at 1-1/2 inches, irrigated, and receiving 4 to 5 lb N/M/yr. Majestic, Geronimo, Adelphi, and Parade were damaged the least by leaf spot; and Kenblue, Vantage, Park, Windsor, and Majestic least by Fusarium. Spring greenup was earliest for Vantage and Ram I.

Treatments that were applied to Pennlawn red fescue consisted of an irrigation variable; all possible combinations of three nitrogen rates--1/2, 1, and 1-1/2 lb N/M--in spring and fall; and three mowing heights--1, 2, and 3 inches. Beneficial effects of irrigation in preventing summer dormancy were offset by increased disease damage. The highest quality turf was produced on plots not irrigated and mowed at 2 inches.

The use of glyphosate (4 lb/A) to kill existing turf and weeds before seeding greatly increased establishment of seeded species. (Cooperative research with NRP 20280)

Repeated applications for 3 years of seven crabgrass control herbicides and two broadleaf herbicide mixtures at three nitrogen levels resulted in only small differences in mean quality and ground cover ratings. Turf quality was lower and ground cover less where DSMA was applied when compared with other crabgrass herbicides. (Cooperative research with NRP 20280)

Fusarium roseum damage of Kentucky bluegrass turf was increased by high phosphorus fertilization. The greatest amount of damage was in plots that received 500 lb or more K_2O/A and 5 lb $N/M/yr$.

Turf quality of tall fescue was increased significantly by aerification and leaving mower clippings on plots. Verticutting (thatch removed) decreased turf quality when compared with no cultivation treatment. Three applications of 10-10-10 at 5 lb/M/yr, not removing clippings, and aerification resulted in turf quality equal to that of three applications of 15 lb/M/yr 10-10-10 with clippings removed and not aerified. Thatch accumulation was not excessive with any of the treatment.

The systemic fungicide Tersan 1991 at 8 oz/M each month for 4 months, and alternated treatments of 1991 and Koban every 2 weeks significantly reduced crown and root production of bentgrass and root production of Kentucky bluegrass. Cleary 3336 and Dyrene alone or in alternate applications had no effect on plant growth.

Zoysiz and Kentucky bluegrass turf were treated with three nematicides, applied at two rates and at two dates to determine effects on clipping yields, appearance, and nematode counts. First-year yields were not significantly different in either experiment. However, in the majority of cases nematicides even at low rates significantly reduced the numbers of nematodes. Monocultures of some common plant parasitic nematodes of turf are being established.

Differential response to lime applications occurred in 36 Kentucky bluegrasses, 18 fineleaf fescues, and 7 tall fescues growing in an acid soil high in exchangeable aluminum. Both inter- and intra-cultivar differences were obtained among fineleaf and tall fescues. Production of vegetative material of Kentucky bluegrass cultivars at pH 4.6 ranged from 3.5 to 62 percent of that produced at pH 5.6. (Beltsville, MD)

OTHER INDICATORS OF PROGRESS:

Germplasm Releases

Name	Location	Cooperators	Date	Type of germplasm ^{1/}
Alfalfa:				
Arc	Beltsville, MD	MD, NC, PA, VA	5/74	C
NC-83-1 and NC-83-2	Lincoln, NE	AK, IL, IN, IA, KS, MN, NE, SD, WI	9/74	B
Nevada Syn. XX	Reno, NV	CA, NV, OR	11/74	B
C-3 Dryland	Fort Collins, CO	CO	2/75	B
Deseret (Kayseri)	Logan, UT	UT	4/75	C
DA-1 and DA-2	Beltsville, MD	--	9/75	B
BIC-17 popula- tions	Beltsville, MD	KS, MN, NE, NV, WA	3/76	B
PA-1	Tucson, AZ	AZ	7/76	B
18 Germplasm Pools	Prosser, WA	WA	8/76	B
WDS3PI and WISIPI	Prosser, WA	WA	8/76	B
Birdsfoot trefoil Group B and Group H	Blacksburg, VA	VA	1/75	B
Virginia Syn. No. 10	Blacksburg, VA	VA	3/75	B
T-68	Ithaca, NY	NY	8/75	B

(continued)

Germplasm Releases (continued)

Name	Location	Cooperators	Date	Type of germplasm ^{1/}
Clovers:				
C-2 Kura Clover	Fort Collins, CO	CO	9/74	B
Grasses:				
Ruff Crested Wheatgrass	Lincoln, NE	NE	7/74	C
Flintlock Western Wheatgrass	Lincoln, NE	NE	1/75	C
Kenhy Tall Fescue	Lexington, KY	KY	1/76	C
Belturf Ky. Blue- grass	Beltsville, MD	--	3/76	C
36 Annual Ryegrass breeding lines (MR-1 through MR-36)	Mississippi State, MS	MS	5/76	B

^{1/} B = Breeding line
C = Cultivar

PUBLICATIONS:

(Listed alphabetically by first ARS author, where coauthored by non-ARS person, without regard to Technological Objective. ARS authors underlined.)

Ahring, R. M., W. W. Huffine, C. M. Taliaferro, and R. D. Morrison. 1975. Stand establishment of bermudagrass from seed. Agron. J. 67:229-232.

Ahring, R. M., J. D. Eastin, and C. S. Garrison. 1975. Seed appendages and germination of two Asiatic bluestems. Agron. J. 67:321-325.

Barker, R. E., and A. B. Frank. 1975. Variation in photosynthesis and water use in three wheatgrass species. Twenty-third Grass Breeders Work Planning Conf. Proc. pp. 52-54, Sept. 9-11. St. Paul, MN.

Barnes, D. K., and M. P. Meyer. 1975. Potential of low altitude remote sensing imagery for identifying pest injury, stage of plant growth, and yield of alfalfa. Fourteenth Central Alfalfa Improvement Conf. Madison, WI.

Buss, G. R., and D. K. Barnes. 1975. Inheritance of a chlorotic seedling trait that affects zygote survival in diploid alfalfa. Crop Sci. 15:185-186.

Lueschen, W. E., D. K. Barnes, D. L. Rabas, F. I. Frosheiser, and D. M. Smith. 1976. Field performance of alfalfa cultivars resistant and susceptible to Phytophthora root rot. Agron. J. 68:281-285.

Seetin, M. W., and D. K. Barnes. 1975. Selecting high nitrogen fixing genotypes in alfalfa. Fourteenth Central Alfalfa Improvement Conf. Madison, WI.

Barnes, R. F., and D. L. Gustine. 1975. Allelochemicals and forage crops. In D. N. Lapedes (Ed.) Yearbook of Science and Technology. pp. 202-203. McGraw-Hill, NY.

Shenk, J. S., R. F. Barnes, J. D. Donker, and G. C. Marten. 1975. Weanling meadow vole and dairy cow responses to alfalfa hay. Agron. J. 67:569-571.

Bula, R. J., D. A. Holt, R. G. May, and M. M. Schreiber. 1975. Environmental physiology, modeling and simulation of alfalfa growth. II. Biomass accumulation characteristics of an alfalfa canopy. Purdue Agr. Exp. Sta. Bul. 76.

- Bula, R. J., M. M. Schreiber, R. G. May, and D. A. Holt. 1975. Environmental physiology, modeling and simulation of alfalfa growth. III. Micrometeorological conditions of an alfalfa canopy. Purdue Agr. Exp. Sta. Bul. 77.
- Saiga, S., R. C. Buckner, and P. B. Burrus, II. 1976. The fluorescent seedling character in ryegrass-tall fescue hybrids and its relation to NVI and rust resistance. Japanese Jour. of Plant Breeding 26(1):1-5.
- Yates, S. C., S. P. Rogovin, L. P. Bush, R. C. Buckner, and J. A. Boling. 1975. Isolation of perloline, the yellow alkaloid of tall fescue. Industrial Engineering Chemistry: Product Research and Development 14:315-319.
- Boling, J. A., L. P. Bush, R. C. Buckner, L. C. Pendlum, P. B. Burrus, S. G. Yates, S. P. Rogovin, and H. L. Tookey. 1975. Nutrient digestibility and metabolism in lambs fed added perloline. J. An. Sci. 40:972-976.
- Burns, J. C., and W. A. Cope. 1976. Estimating the nutritive value of forages containing tannin and phenols by chemical bioassay methods. Agron. J. 68:72-74.
- Cummings, G. A., J. C. Burns, R. E. Sneed, M. R. Overcash, and F. J. Humenik. 1975. Plant and soil effects of swine lagoon effluent applied to Coastal bermudagrass. Proc. 3rd International Symposium on Livestock Wastes.
- Goode, L., J. C. Burns, D. J. Moncol, and A. C. Linnerud. 1975. Grazing systems for the cow-calf enterprise. Annual Beef Cattle Report 230. Dept. of Animal Science, North Carolina State University. (Technical Research Report) pp. 28-30.
- Harvey, R. W., J. C. Burns, T. H. Blumer, and A. C. Linnerud. 1975. Influence of early weaning on calf and pasture productivity. Jour. Anim. Sci. 41:740-748.
- Burton, Glenn W. 1975. Recurrent restricted phenotypic selection to increase forage yields. Proc. 23rd Grass Breeders Work Planning Conference. pp. 45-47.
- Burton, Glenn W. 1975. Breeding superior forages. Forage Research 1(1):23-20.
- Burton, Glenn W. 1976. Potential for hybrid varieties in perennial forage species. Proc. 30th and 31st Southern Pasture and Forage Crop Improvement Conference. pp. 40-45.
- Burton, Glenn W. 1976. Gahi 3 millet promising crop. Goldkist News. 26(9):8 March.

Burton, G. W. 1976. Gahi 3 makes more beef. Southeast Farm Weekly 8(10):6.

Burton, G. W. 1976. Trends, problems, and issues ahead in world food production. Proc. Project 2000 Forum. Iowa State University.

Burton, G. W. 1976. Gene loss in pearl millet germplasm pools. Crop Sci. 16(2):251-255.

Burton, G. W., J. B. Powell, and W. W. Hanna. 1975. Effect of recurrent mutagen seed treatments on mutation frequency and combining ability for forage yield in pearl millet (Pennisetum americanum (L.) K. Schum). Radiation Bot. 14:323-335.

Burton, G. W., W. G. Monson, W. W. Hanna, and M. J. Constantin. 1975.

Silage production and quality of pearl millet, sorghum, and corn hybrids grown from seed exposed to low doses of gamma rays. Radiation Bot. 15:33-38.

Campbell, W. V., T. H. Busbice, J. M. Falter, and J. W. Glover. 1975. Alfalfa weevil and its management in North Carolina. N.C. Exp. Sta. Tech. Bul. No. 234.

Byers, R. A., and K. E. Zeiders. 1976. Effect of spray irrigation with municipal sewage effluent on the cereal leaf beetle and the frit fly infesting reed canarygrass. J. Environ. Qual. 5:205-206.

Canode, C. L., and A. G. Law. 1975. Seed production of Kentucky bluegrass associated with age of stand. Agron. J. 67:790-794.

Chatterton, N. J., W. W. Hanna, J. B. Powell, and D. R. Lee. 1975. Photosynthesis and transpiration of bloom and bloomless sorghum. Can. Jour. of Plant Sci. 55(2):641-643.

Cooper, C. S. 1975. Influence of harvest management and mid-season nitrogen fertilization on yield, botanical composition and crude protein content of grass-legume mixtures. Mont. Agr. Exp. Sta. Bul. 676.

Ditterline, R. L., and C. S. Cooper. 1975. Fifteen years with sainfoin. Mont. Agr. Exp. Sta. Bul. 681.

Ditterline, R. L., C. S. Cooper, L. E. Wiesner, J. R. Sims, and V. R. Stewart. 1976. Growing alfalfa in Montana. Mont. Agr. Exp. Sta. Bul. 684.

Devine, T. E., C. D. Foy, A. L. Fleming, C. H. Hanson, T. A. Campbell, J. E. McMurtrey, III, and J. W. Schwartz. 1976. Development of alfalfa strains with differential tolerance to aluminum toxicity. Plant and Soil 44:73-79.

- Devine, T. E., and J. E. McMurtrey, III. 1975. Performance of anthracnose-resistant alfalfa strains. Crop Sci. 15:505-508.
- Devine, T. E., R. H. Ratcliffe, C. M. Rincker, D. K. Barnes, S. A. Ostazeski, T. H. Busbice, C. H. Hanson, J. A. Schillinger, G. R. Buss, and R. W. Cleveland. 1975. Registration of Arc alfalfa. Crop Sci. 15:97.
- Elgin, J. H., Jr., D. W. Evans, and L. R. Faulkner. 1975. Swelling response of alfalfa seedlings to initial stem-nematode infection. Crop Sci. 15:435-437.
- Feldmesser, J., S. A. Ostazeski, and A. M. Golden. 1975. Nematodes in forage grasses. J. Nematol. 7:321.
- Forbes, I. 1976. Exploring for forage legumes in the Western Mediterranean. Proc. 30th and 31st Southern Pasture and Forage Crop Improvement Conference. USDA-ARS. pp. 188-191.
- Forbes, I., J. S. Gladstones, and H. D. Wells. 1975. Gray leaf spot-resistant Lupinus angustifolius L. germplasm from plant exploration in the Western Mediterranean region. Crop Sci. 15:867-868.
- Forbes, I., J. S. Gladstones, and H. D. Wells. 1975. Gray leaf spot-resistant Lupinus angustifolius L. germplasm from plant exploration in the Western Mediterranean region. Clovers and Special Purpose Legumes Research. R. R. Smith (ed.) USDA-ARS Coop. Dept. Agron. U. Wisconsin, Madison 8:4.
- Frank, A. B., and R. E. Barker. 1976. Rates of photosynthesis and transpiration and diffusive resistance of six grasses grown under controlled conditions. Agron. J. 69:487-490.
- Wilcoxson, R. D., L. E. B. Johnson, and F. I. Frosheiser. 1975. Variation in the aggregation forms of alfalfa mosaic virus strains in different alfalfa organs. Phytopathology 65:1249-1254.
- Johnson, L. E. B., R. D. Wilcoxson, and F. I. Frosheiser. 1975. Transfer of cells in tissues of the reproductive system of alfalfa. Can. J. Bot. 53:952-956.
- Gibson, P. B., and Chi-Chang Chen. 1975. Registration of SC-2 and SC-3 clover germplasms. Crop Sci. 15:605-606.
- Barnett, O. W., P. B. Gibson, and A. Seo. 1975. A comparison of heat treatment, cold treatment, and meristem tip-culture for obtaining virus-free plants of Trifolium repens. Plant Dis. Reprtr. 10:834-837.

- Gorz, H. J., G. R. Manglitz, and F. A. Haskins. 1975. Resistance of red clover to the clover leaf weevil. *Crop Sci.* 15:279-280.
- Gorz, H. J., J. E. Specht, and F. A. Haskins. 1975. Inheritance of seed and seedling color in sweetclover. *Crop Sci.* 15:235-238.
- Haskins, F. A., and H. J. Gorz. 1975. Influence of seed size, planting depth, and companion crop on emergence and vigor of seedlings in sweet-clover. *Agron. J.* 67:652-654.
- Ronnenkamp, R. R., H. J. Gorz, and F. A. Haskins. 1975. Genetic studies of induced mutants in Melilotus alba. IV. Inheritance and complementation of six additional chlorophyll-deficient mutants. *Crop Sci.* 15:187-188.
- Specht, J. E., H. J. Gorz, and F. A. Haskins. 1976. Genetic regulation of flavonoid content in seeds and seedlings of Melilotus alba. *Phytochemistry* 15:133-134.
- Specht, J. E., F. A. Haskins, and H. J. Gorz. 1975. Contents of chlorophylls a and b in chlorophyll-deficient mutants of sweetclover. *Crop Sci.* 15:851-853.
- Graham, J. H., T. E. Devine, J. E. McMurtrey, and D. L. Fleck. 1975. Agar plate method for selecting alfalfa for resistance to Colletotrichum trifolii. *Plant Dis. Repr.* 59:382-384.
- Gustine, D. L., W. A. Kendall, and R. T. Sherwood. 1976. Palatability of forages tested via meadow voles. *Sci. Agr.* 23(3):4.
- Shenk, J. S., P. J. Wangsness, R. M. Leach, D. L. Gustine, J. L. Gobble, and R. F. Barnes. 1976. Relationship between β -nitropropionic acid content of crownvetch and toxicity in nonruminant animals. *J. Anim. Sci.* 42:616-621.
- Hanna, W. W., W. G. Monson, and G. W. Burton. 1976. Histological and in vitro digestion study of 1- and 4-week stems and leaves from high and low quality bermudagrass genotypes. *Agron. J.* 68:219-222.
- Hardison, J. R. 1975. Chemical prevention of ascocarp formation in Claviceps purpurea. *Phytopathology* 65:502-503.
- Hardison, J. R. 1975. Chemical suppression of apothecial formation in Gloeotinia temulenta. *Plant Dis. Repr.* 59:229-231.
- Hardison, J. R. 1975. Field burning and grass disease control. In Oregon State University Research on Field Burning. Oregon State University Circular of Information 647:34-39.
- Hardison, J. R. 1975. Control of Puccinia striiformis by two new systemic fungicides, BAY MEB 6447 and BAS 31702F. *Plant Dis. Repr.* 59:652-655.

Hill, R. R., Jr. 1975. Parental inbreeding and performance of alfalfa singlecrosses. Crop Sci. 15:373-375.

Hill, R. R., Jr., and G. A. Jung. 1975. Genetic variability for chemical composition of alfalfa. I. Mineral elements. Crop Sci. 15:652-657.

Hill, R. R. Jr., and K. T. Leath. 1975. Genotypic and phenotypic correlations for reaction to five foliar pathogens in alfalfa. Theor. Appl. Genet. 45:254-258.

Hunt, O. J., D. K. Barnes, R. N. Peaden, and B. J. Hartman. 1976. Inheritance of black seed character and its use in alfalfa improvement. Proc. 25th National Alfalfa Conference, Cornell University, Ithaca, NY.

Guenthner, H. R., and O. J. Hunt. 1976. Selecting an alfalfa variety. Nevada Cooperative Ext. Serv. Circ. 122. 5 pp. (revised).

Jung, G. A., R. E. Kocher, C. F. Gross, C. C. Berg, and O. L. Bennett. 1976. Nonstructural carbohydrate in the spring herbage of temperate grasses. Crop Sci. 16:353-359.

Kendall, W. A., and K. T. Leath. 1975. Effect of saponins on palatability of alfalfa to meadow voles. Agron. J. 68:473-476.

Kendall, W. A., and R. T. Sherwood. 1975. Palatability of leaves of tall fescue and reed canarygrass and of some of their alkaloids to meadow voles. Agron. J. 67:667-671.

Kehr, W. R. 1976. Cross-fertilization in seed production in relation to forage yield in alfalfa. Crop Sci. 16:81-86.

Kehr, W. R., D. K. Barnes, E. L. Sorenson, W. H. Skrdla, C. H. Hanson, D. A. Miller, T. E. Thompson, I. T. Carlson, L. J. Elling, R. L. Taylor, M. D. Rumbaugh, E. T. Bingham, D. E. Brown, and M. K. Miller. 1975. Registration of alfalfa germplasm pools NC-83-1 and NC-83-2. Crop Sci. 15:604-605.

Kehr, W. R., R. L. Ogden, and S. D. Kindler. 1975. Management of four alfalfa varieties to control damage from potato leafhopper. Nebraska Agr. Exp. Sta. Res. Bul. 275. 42 pp.

Kugler, J. L., W. R. Kehr, and R. L. Ogden. 1975. Comparative measures of mirid damage on alfalfa forage. Proc. 14th Central Alfalfa Improvement Conference. p. 9

Klebesadel, L. J. 1975. A look at forage research in the Soviet Union: Alaska's interests *Agroborealis* 7(1):4-10.

Klebesadel, L. J. 1976. Early planting is important to Alaska growers of bluegrass and red fescue seed. *Agroborealis* 8(1):22-24.

Klingman, D. L., and J. J. Murray. 1976. Germination of seeds of turf-grasses as affected by glyphosate and paraquat. *Weed Sci.* 24:191-193.

Smith, C. M., W. E. Knight, and H. N. Pitre. 1975. Feeding preference of the clover head weevil on clovers of the genus Trifolium. *J. Econ. Entom.* 68:165-166.

Smith, C. M., H. N. Pitre, and W. E. Knight. 1975. Evaluation of crimson clover for resistance to leaf feeding by the adult clover head weevil. *Crop Sci.* 15:257-258.

Smith, C. M., H. N. Pitre, and W. E. Knight. 1975. Evaluation of crimson clover seed damage by the clover head weevil. *Florida Entomologist* 58(2):113-116.

Watson, V. H., W. E. Knight, and R. E. Coats. 1975. Pasture renovation and overseeding programs for the lower south. *Proc. National No-Till Symposium.* Columbus, Ohio, October 14-16.

Leath, K. T. 1975. Plant pathology program at the U.S. Regional Pasture Research Laboratory. *Pennsylvania Grassland News* 15(1):1-3.

Leath, K. T., and J. E. Baylor. 1975. *Phytophthora* root rot of alfalfa in Pennsylvania. *Plant Dis. Reptr.* 59:972-974.

Leath, K. T., and R. R. Hill, Jr. 1975. Factors affecting alfalfa stand persistence--role of diseases. *Ann. Alfalfa Symp. Proc.* 5th (Hershey, PA) pp. 96-102.

Leath, K. T., W. A. Kendall, and R. A. Byers. 1975. *Fusarium* root rot: interactions and techniques. *Eastern Forage Impr. Conf.* 1st (Guelph, Ont.) pp. 35-38.

Marten, G. C. 1975. Directions for forage research. *In Proc. 8th Res.-Indust. Conf. Amer. Forage and Grassland Council,* Omaha, Nebraska. pp. 82-97.

Marten, G. C., and R. N. Andersen. 1975. Forage nutritive value and palatability of twelve common annual weeds. *Crop Sci.* 15:821-827.

Marten, G. C., R. D. Goodrich, R. M. Jordan, A. R. Schmid, and J. C. Meiske. 1976. Evaluation of laboratory methods for determining quality of corn and sorghum silages: III. Biological and chemical methods for predicting animal intake. Agron. J. 68:289-291.

Donker, J. D., G. C. Marten, R. M. Jordan, and P. K. Bhargava. 1976. Effects of drying on forage quality of alfalfa and reed canarygrass fed to lambs. J. Anim. Sci. 42:180-184.

Hovin, A. W., and G. C. Marten. 1975. Distribution of specific alkaloids in reed canarygrass cultivars. Crop Sci. 15:705-707.

Schmid, A. R., R. D. Goodrich, R. M. Jordan, G. C. Marten, and J. C. Meiske. 1976. Relationship of agronomic characteristics of corn and sorghum cultivars to silage quality. Agron. J. 68:403-406.

Matches, A. G., S. Bell, M. Mitchell and F. A. Martz. 1975. Pasture systems for season-long grazing. Research Reports 1975, College of Agriculture, University of Missouri-Columbia Special Report 177. pp. 8-11.

Matches, A. G., and G. O. Mott. 1975. Estimating the parameters associated with grazing systems. In Proc. III World Conference on Animal Production. R. L. Reid (ed.). pp. 203-208.

Matches, A. G., G. B. Thompson and F. A. Martz. 1975. Post-establishment harvesting and management system of forages. Proc. No-Tillage Forage Symposium. October 15-16, 1975. Ohio State University and OARDC, Columbus, Ohio. pp. 111-135.

Martz, F. A., S. Bell, M. Mitchell, A. G. Matches, and D. A. Sleper. 1975. Advanced fescue evaluation studies--a team research project. Research Report 1975. College of Agriculture, University of Missouri-Columbia Special Report 177. pp. 12-17.

Stricker, J. A., V. E. Jacobs, G. B. Thompson, F. A. Martz, A. G. Matches, H. N. Wheaton, H. D. Currence, and C. L. Mottesheard. 1976. 1976 Field Day Report Forage Systems Research Center. University of Missouri-Columbia, College of Agriculture. 36 pp.

Miller, J. D. 1975. Registration of Group B birdsfoot trefoil germplasm pool. Crop Sci. 15:889-890.

Miller, J. D. 1975. Registration of Group H birdsfoot trefoil germplasm. Crop Sci. 15:890.

Miller, J. D. 1976. Registration of Virginia number 10 birdsfoot trefoil germplasm. Crop Sci. 16:126.

- Miller, J. D., P. B. Gibson, W. A. Cope, and W. E. Knight. 1975. Herbivore feeding on cyanogenic and acyanogenic white clover seedlings. *Crop Sci.* 15:90-91.
- Roane, M. K., and J. D. Miller. 1976. *Uromyces nerviphilus* on inter-specific hybrids of *Trifolium repens* in Virginia. *Plant Dis. Reptr.* 60:432-433.
- Murray, J. 1975. Practices contributing to thatch accumulation and control. *Proc. 15th Virginia Turfgrass Conf.* pp. 10-12.
- Murray, J. J., R. K. Howell, and A. C. Wilton. 1975. Differential response of seventeen *Poa pratensis* cultivars to ozone and sulfur dioxide. *Plant Dis. Reptr.* 59:852-854.
- Ostazeski, S. A., T. E. Poole, A. C. Wilton, and J. J. Murray. 1975. Polyembryony in Kentucky bluegrass as a source of variation in disease reaction. *Crop Sci.* 15:820-821.
- Peaden, R. N., O. J. Hunt, L. R. Faulkner, G. D. Griffin, H. J. Jensen, and E. H. Stanford. 1976. Registration of a multiple-pest resistant alfalfa germplasm (Reg. No. G.P. 51). *Crop Sci.* 16:125-126.
- Pedersen, M. W., D. K. Barnes, E. L. Sorensen, G. D. Griffin, M. W. Nielson, R. R. Hill, Jr., F. I. Frosheiser, R. M. Sonoda, C. H. Hanson, O. J. Hunt, R. N. Peaden, J. H. Elgin, Jr., T. E. Devine, M. J. Anderson, B. P. Goplen, L. J. Elling, and R. E. Howarth. 1976. Effects of low and high Saponin selection in alfalfa on agronomic and pest resistance traits and the interrelationship of these traits. *Crop Sci.* 16:193-199.
- Pedersen, M. W., E. L. Sorensen, and M. J. Anderson. 1975. A comparison of pea aphid-resistant and susceptible alfalfas. *Crop Sci.* 15:254-256.
- Powell, J. B. 1975. Anatomical features of grasses influencing *in vitro* digestibility. *Proc. 23rd Grass Breeders Work Planning Conf.* pp. 25-28.
- Powell, J. B., W. W. Hanna, and G. W. Burton. 1975. Origin, cytology, and reproductive characteristics of haploids in pearl millet, *Pennisetum americanum* (L.) K. Schum. *Crop Sci.* 15:389-392.
- Rincker, C. M. 1976. Alfalfa seed yields from seeded rows vs spaced transplants. *Crop Sci.* 16:268-270.
- Sherwood, R. T., and C. P. Vance. 1976. Histochemistry of papillae formed in reed canarygrass leaves in response to noninfecting pathogenic fungi. *Physopathology* 66:503-510.
- Smith, R. R., and D. Rohweder. 1975. Arlington red clover. *Wis. Col. Agr. Life Sci. Res. Rept.* R2762. 4 pp.

Engelke, M. C., R. R. Smith, and D. P. Maxwell. 1975. Evaluating red clover germplasm for resistance to leaf rust. *Plt. Dis. Reprtr.* 59:959-963.

Murray, G. M., D. P. Maxwell, and R. R. Smith. 1976. Screening red clover and other *Trifolium* species for resistance to *Stemphylium sarcinaeforme*. *Plt. Dis. Reprtr.* 60:35-37.

Roof, M. E., E. Horber, and E. L. Sorensen. 1976. Evaluating alfalfa cuttings for resistance to the potato leafhopper. *Environmental Ent.* 5:295-301.

Vance, C. P., and R. T. Sherwood. 1976. Cycloheximide treatments implicate papilla formation in resistance of reed canarygrass to fungi. *Phytopathology* 66:498-502.

Vogel, K. P., V. A. Johnson, and P. J. Mattern. 1975. Reevaluation of common wheat from the USDA World Wheat Collection for protein and lysine content. *Nebr. Agr. Exp. Sta. Res. Bul.* 272. 36 pp.

Johnson, V. A., P. J. Mattern, and K. P. Vogel. 1975. Cultural, genetic, and other factors affecting quality of wheat. In Arnold Spencer (ed.) Bread, Social, Nutritional, and Agricultural Aspects of Wheat Bread. pp. 127-140. Applied Science Publisher LTD.

Voigt, P. W., W. R. Kneebone, J. R. Harlan, and R. M. Ahring. 1975. Registration of Texoka buffalograss. *Crop Sci.* 15:885.

Welty, R. E., and T. H. Busbice. 1976. *Phytophthora* root rot of alfalfa in North Carolina. *Plant Dis. Reprtr.* 60:14-18.

Dickens, J. W., and R. E. Welty. 1975. Fluorescence in pistachio nuts contaminated with aflatoxin. *J. Amer. Oil Chem. Soc.* 52:448-450.

Zeiders, K. E. 1975. *Stagnospora foliicola*, a pathogen of reed canarygrass spray-irrigated with municipal sewage effluent. *Plant Dis. Reprtr.* 59:779-783.

NRP Annual Report
FY 1976

NRP 20110 Improved Vegetation and Management Practices for Range

NPS Contact: R. F. Barnes

PACS Contact: L. L. Jansen

MISSION: This program is part of the USDA-ARS mission on Agricultural Production Efficiency with the goal to develop new knowledge to increase productivity from improved vegetation and management practices for range.

ARS range research is responsible for both a resource (rangeland) and a commodity (animal products). Our mission is to conserve and improve the resource and increase animal production from the utilization of that resource.

- TO 1 Acquire, describe, and evaluate new germplasm; and develop and test improved cultivars of grasses, legumes, shrubs, and forbs with increased ease of establishment, productivity, forage quality, persistence, improved seed qualities, and tolerance to grazing, and with reduced losses from anti-quality constituents, pests, and environmental hazards.
- TO 2 Develop range improvement practices for increasing productivity of rangeland.
- TO 3 Develop grazing (forage-livestock) management systems which convert range forage more efficiently to animal products and are consistent with improvement, conservation, and multiple use of range ecosystems.

SELECTED EXAMPLES OF PROGRESS:

These examples are assembled by individual Technological Objectives. The general order within TO's is to discuss legumes first, followed by grasses.

- TO 1 Acquire, describe, and evaluate new germplasm; and develop and test improved cultivars of grasses, legumes, shrubs, and forbs with increased ease of establishment, productivity, forage quality, persistence, improved seed qualities, and tolerance to grazing, and with reduced losses from anti-quality constituents, pests, and environmental hazards.

The effectiveness of phenotypic recurrent selection for seed size and mature plant vigor was determined in diallel and polycross populations of cicer milkvetch (Astragalus cicer). Significant differences among populations exist for green weight of forage, vigor score, height, data flowering, and seed weight. Mean seed weight of four populations ranged

from 4.303 to 4.733 g/1000 seeds. This represents an increase of 21.8 to 34.7 percent over the original populations. There were vigorous progenies in all populations, but the most vigorous were from the diallel populations. The prospects for additional improvement in forage yield in these populations are not high because differences among progenies within the diallel populations were not significant for a vigor score in the year following establishment. Variability for the initiation of spring growth was of sufficient magnitude to suggest that significant improvement can be made in selecting for this trait. (Fort Collins, CO)

Sexual germplasm of weeping lovegrass (Eragrostis curvula) has been discovered and a germplasm release made. Previously, only apomictic (asexual) germplasm was available. Hybridization among the wide diversity of apomictic forms with E. curvula and closely related species is now possible. The first hybrids between E. curvula and E. lehmanniana have been produced and new combinations of characteristics can now be obtained and new cultivars developed. The inheritance of apomixis in E. curvula is not yet clear and studies are underway to resolve the situation. (Temple, TX)

More than 200 collections of crested wheatgrass, Agropyron cristatum, from Iran were studied with respect to geographic origin, cytology, morphology, and fertility. In Iran, crested wheatgrasses occurred at latitudes north of 35° and at elevations between 600-3400m. Tetraploid collections, 2n=28, were the most common, followed by hexaploids 2n=42, and diploids, 2n=14. The polyploid races behaved cytologically as autopolyploids. Significant variation in maturity, height, texture, fertility, seed size, and rhizome development occurred between and within collections. More than half of the collections were rhizomatous, a character that might be of importance in a plant breeding program. (Logan, UT)

Hybrids of Agropyron repens, quackgrass, (2n=42) X A. spicatum, blue-bunch wheatgrass, (2n=28) were intercrossed, backcrossed, and open-pollinated. The hybrid derivatives differed widely in vigor, rhizome development, spike characteristics, and fertility. By the F₅ generation, the hybrid population was largely hexaploid (2n=42), and some plants had achieved meiotic stability and full fertility. Almost 1/4 of the F₅'s were nonrhizomatous. The advanced-generation hybrids appear to have potential as economically important forage grasses. (Logan, UT)

Two collections of Elymus ambiguus from Utah and Idaho were 2n=28, and they behaved cytologically as allotetraploids. Chromosome pairing in interspecific hybrids indicated that E. ambiguus has one genome in common with diploid E. junceus and two genomes in common with tetraploid E. innovatus, E. multicaulis, and E. karataviensis. (Logan, UT)

A crested wheatgrass (Agropyron cristatum and desertorum) source nursery (20,000 spaced plants) was established and rated initially for winter hardiness, disease and insect resistance, and early season productivity. Available genetic diversity of Russian wildrye (Elymus junceus) was assembled and established in a source nursery on a range site. Studies to determine the agronomic potential of 25 interspecific and intergeneric hybrids were continued near Logan and in Idaho. Selections from promising hybrid populations including A. repens X A. spicatum, A. repens X A. desertorum, and A. spicatum X A. dasystachyum were established and rated in field nurseries. (Logan, UT)

Superior genotypes of blue panicgrass (Panicum antidotale Retz.) selections were isolated through six cycles of recurrent selection and restricted recombination. Progeny of the sixth cycle of selection were evaluated for individual traits including seed weight, seedling drought tolerance, rate of germination, and the effect of substrate moistening agents of chlorides and mannitol during germination. (Tucson, AZ)

Germplasm source populations of intermediate wheatgrass, orchardgrass, reed canarygrass, crested wheatgrass, Russian wildrye, and western wheatgrass were evaluated on an individual plant basis for vigor, general appearance, and maturity. Seed from each plant within each population was harvested and equal amounts bulked to produce the first cycle improvement breeding populations. Selected plants within each source population have been noted and will be evaluated further. Twelve clones of orchardgrass, selected for winter survival, were propagated and established in a diallel crossing block. (Mandan, ND)

TO 2 Develop range improvement practices for increasing productivity of rangeland.

Alfalfa and orchardgrass survived equally well and produced the same amount of hay regardless of whether irrigation was stopped September 23 or October 11, the preceding year. Alfalfa produced 2300 lbs/acre of dry matter, and alfalfa plants occupied 91 percent of the total space in the row. Corresponding figures for orchardgrass were 3300 lbs/acre 84 percent, respectively. (Cheyenne, WY)

The effects of legumes on forage yields of seeded range grasses was determined with alfalfa, crownvetch, sainfoin, and sickle milkvetch planted in alternate rows with crested wheatgrass, pubescent wheatgrass, and Russian wildrye. Crownvetch failed to establish a stand, but all other legumes and all grasses produced excellent initial stands when seeded in 1971. By 1975, the stand of sainfoin was reduced to less than half its original stand, and sickle milkvetch was also reduced. Stands of alfalfa in all grasses remained excellent, and in 1975 the highest total yields were from the grass-alfalfa mixtures. These mixtures averaged

3,025 pounds per acre, while the grasses grown alone averaged 1,843 pounds per acre. In the mixtures, crested wheatgrass produced 50 percent more than alfalfa; Russian wildrye and alfalfa were nearly equal; but alfalfa produced twice as much as pubescent wheatgrass. Pubescent wheatgrass appeared to be less well adapted, and the upright growth form of crested wheatgrass as contrasted with the basal growth of Russian wildrye indicates that the crested wheatgrass-alfalfa mixture is best for dry-land hay production on this site. (Fort Collins, CO)

Frequency and cover data of shrubs, grasses, and forbs were collected at 23 locations in 6 habitat types on 3 allotments under rest-rotation grazing management. Seed production of desirable grasses was 2.2 lbs/acre compared to 12.5 lbs/acre by less desirable species in different plant communities. Squirreltail plants produced more seed when fertilized with 40 lbs/acre nitrogen than when competition was removed, or than the check. (Reno, NV)

An area infested with mesquite was aerially sprayed twice during 1958-61. A good stand of mesa dropseed was established shortly thereafter. The average production in 1975 was 152 lbs/acre with unsprayed areas producing about 5 lbs/acre. The mesquite canopy was 2.6 percent and is essentially unchanged since 1963. The benefits from mesquite control are long-lived. (Las Cruces, NM)

Creosotebush was rootplowed, and the area was seeded in 1972 using the method to improve soil water and temperature. The average production in 1975 was 1457 lbs/acre consisting of 56 percent Lehmann lovegrass, 33 percent Boer lovegrass, and the remainder made up of blue grama, blue panicgrass, and yellow bluestem. Since areas infested with creosotebush produce virtually no useful vegetation, this method provides a basis for reclaiming these sites. Average production at 2 sets of protection plots was 582 and 377 lbs/acre. No significant differences existed in production where all animals grazed; livestock were excluded; rabbits and livestock were excluded; and rodents, rabbits, and livestock were excluded. At the second set of plots, there was significantly more production where rabbits and livestock were excluded than where rodents, rabbits, and livestock were excluded (514 vs. 239 lbs/acre). (Las Cruces, NM)

Eastern gamagrass or corngrass (Tripsacum dactyloides) produced 10 tons dry matter per acre under irrigation from 3 cuttings in 1975. Yields from 3 clipping heights were about equal in 1975, but crown spread and vigor in 1976 was greatly reduced by clipping at 3 inches. First-cut yields in 1976 were 3 to 4 tons/acre. In vitro dry matter disappearance of 35-day-old corngrass was 60 percent compared to Midland bermudagrass 45 percent, and alfalfa 64 percent. Young rootstalks (tiller crowns with

leaves) of corngrass propagated 95 to 100 percent; whereas, older and deeper rootstalks (rhizome-like without leaves) propagated only 5 to 10 percent. Field sprigging success with young corngrass rootstalks was highly correlated with root reserves. Storage of young corngrass rootstalks in a moist media for 30 days at 42° to 50° F. resulted in 80 to 90 percent viability. (Woodward, OK)

Long term observations of 240 species and varieties planted at up to 10 pinyon-juniper sites showed 64 species present for 21 to 28 years; 54 with stands rated fair to excellent; and 30 stands spreading. Temperature and moisture were more important than soils in determining plant establishment and adaptation with warm-moist sites most favorable and cool-dry sites poorest. Widely adapted species are: Agropyron smithi, A. trichophorum, Atriplex canescens, Bothriochloa ischaemum, Bouteloua curtipendula, B. gracilis, Muhlenbergia wrighti and Tridens elongatus. Atriplex canescens, A. semibaccata, Eurotia ceratoids, and Kochia prostrata should be tested further. (Flagstaff, AZ)

Growth drought tolerance and growth drought avoidance for blue grama (Bouteloua gracilis) is being quantified. The quantification of all variables that contribute to growth drought resistance will aid in selection of superior seedlings and in definition of planting requirements. Growth drought tolerance varied among seedlings from about -20 to -40 bars. Drought avoidance is related to maximum capacity for water uptake and maximum resistance to water loss. Maximum rates of water uptake by the seminal root varied from 1 to 8 g/day and total leaf diffusion resistance varied from 6 to 24 sec/cm. (Fort Collins, CO)

Root development of forage grass species provides a mechanism of survival under arid and semi-arid rangeland conditions. Seminal lateral roots which develop in the early stages of germination of grasses such as crested wheatgrass (Agropyron desertorum) and Russian wildrye (Elymus junceus), increased the survival of such plants under drought stress. In that capacity, crested wheatgrass is superior to Russian wildrye. Species, such as blue grama, lack the capacity for seminal root development, and establishment of seedlings depends on the extension of one or more adventitious roots in the moist soil. Seedling blue grama plants need a period of 2 to 4 consecutive days of moist soil surface for the initiation and growth of adventitious roots to provide plant establishment. Without these rare weather conditions, blue grama seedlings die before establishment. (Fort Collins, CO)

Methods are being developed for the establishment of desirable range forage grasses on the more than 1 million acres of saltgrass-meadows in the Central Great Plains. Naturstolls or solonetz soils in the area have a high water table and are saline-alkaline. Desirable species such as western wheatgrass and alkali sacaton have been displaced by saltgrass,

an unpalatable grass for livestock. A satisfactory method for eradicating saltgrass with the herbicide glyphosate has been developed. Plowing to a depth that just mixes the A and B soil horizons is recommended to avoid mixing the saline C horizon in with the top two horizons. The establishment of recommended species such as tall wheatgrass, crested wheatgrass, smooth brome grass, and Russian wildrye is difficult where the C horizon has been plowed to the surface and mixed with the other horizons. The high salt content of the C horizon prevents or greatly reduces the development of advantageous roots in the grass seedlings. However, tall wheatgrass appears to be least affected and is more easily established on adverse sites. Greenhouse studies demonstrated that nitrogen fertilization at a field rate of 100 pounds per acre on an A and B mixed soil increased forage yields over 50 percent compared to the A and B mix without fertilization. Herbage yield from A and B horizons in a mixture of the two averaged 10 times that of C horizon alone and was double the yield of a mixture of A, B, and C horizons in the greenhouse. (Fort Collins, CO)

TO 3 Develop grazing (forage-livestock) management systems which convert range forage more efficiently to animal products and are consistent with improvement, conservation, and multiple use of range ecosystems.

Cattle diets on native range consisted of 59 percent western wheatgrass, 15 percent blue grama, 13 percent other grasses and sedges, 7 percent globemallow, and 6 percent other forbs from June through September. Dry matter digestibility of western wheatgrass decreased from 92 percent when growth started in May to 48 percent in September; digestibility of blue grama remained at 55 to 60 percent throughout the season. (Cheyenne, WY)

Crested wheatgrass (43 A) + native range (474 A) carried 269 AUM or 0.52 AUM/A, while native range alone (728 A) carried 186 AUM or 0.26 AUM/A during an 8-month grazing season. Average daily gains of heifers and cows were 0.57 and 0.45 lb, respectively, on crested + range vs. 0.49 and 0.27 on range alone. Weaning weight of calves on crested + range was 414 lb, for a weaned weight of 17.6 lb/A, vs. weaning weight of 400 lb and weaned weight of 10.0 lb/A on range alone. However, breeding efficiency was greater on range alone, averaging 1 conception/1.8 services vs. 1 conception/3.2 services on crested + range. Range herbage dry matter yields were 1160 lb/A on Albinas loam (25 percent of area) and 770 lb/A on Archerson fine sandy loam and similar soils (75 percent of area) for an average yield of 860 lb/A. Crested produced 1800 lb/A of herbage dry matter. (Cheyenne, WY)

A summary of complementary pasture systems of mixed native range and improved grassland has increased beef production and profits over native range alone. The systems included: (1) 90 percent range--10 percent lovegrass increased beef and profits 50 percent; (2) 75 percent range--25 percent wheat-sudangrass doubled beef and profits; and (3) 50 percent lovegrass--50 percent wheat-sudangrass quadrupled beef and profits. Woodward, OK)

Charolais X Hereford yearling weight gains of 2.2 lbs/day resulted from grazing from June 4 to October 8 on combinations of crested wheatgrass, native summer range, and native irrigated meadow with minimal supplementation with grain or alfalfa hay in the fall. Carcasses graded utility due to very thin fat thickness. Good consumer acceptance was found in rural areas. (Reno, NV)

The use of yearling steers to evaluate forage management systems through grazing studies involving use of seeded and natural grasslands remains the core of the forage program at Mandan. Methods of incorporating basic information on the response of native and introduced species to intensive management practices into grazing systems are being evaluated. These intensive management practices appear capable of more than doubling the production of animal products on Northern Plains grassland. A new long term grazing study was established in fiscal year 1975. Blue grama and sideoats grama, seeded alone and in mixture with western wheatgrass and crested wheatgrass, will be compared with and without fertilizer and for different seasons of use. (Mandan, ND)

In the second year of an overwintering study, cows, when wintered on standing meadow hay cured with paraquat, lost 0.04 lbs/day over the 113-day trial period. This was an acceptable weight loss. The wintering cost was 9¢ per animal unit day, compared with 24¢ for the conventional system of processing and feeding hay. Paraquat at 0.2 lbs/acre was as effective as 0.5 lbs/acre in curing meadow species. (Burns, OR)

Replicated pastures of abandoned cropland (land previously plowed and planted to wheat, but abandoned and allowed to revegetate naturally since the mid-1930's) has been fertilized with 0 and 22 kg/ha nitrogen annually since 1972. All pastures were grazed from about mid-May until about mid-October annually since 1972. Results in 1975 show that 22 kg nitrogen has significantly reduced redthreawn, an unpalatable grass of low forage value, and increased foxtail barley and Russian thistle. The applied nitrogen also increased slimleaf goosefoot, an annual forb of little forage value, but one that concentrates nitrate-N to levels potentially toxic to cattle. The applied nitrogen increased both grazing capacity and animal gain per acre about 50 percent. In 1975, yearling daily gains were 1.88 and 2.05 pounds; stocking rates were 15.2 and 43.6 yearling days of grazing per acre; and animal gains per acre for 37.6 and 53.7 pounds on unfertilized and fertilized pastures, respectively. The unfertilized, abandoned cropland produced nearly twice as much beef per acre as adjacent, good-condition blue grama range. Comparable values for three half-section blue grama pastures in 1975 were 1.78 pounds average daily gain, 11.1 animal days of grazing per acre, and 19.8 pounds of animal gain per acre, which is slightly better than the long time average for blue grama rangeland. (Fort Collins, CO)

OTHER INDICATORS OF PROGRESS:

Germplasm Releases

Name	Location	Cooperators	Date	Cultivar (C) on Breeding line (B)
Texoka Buffalograss	Lincoln, NE	OK, KS, TX and SCS	8/74	V
OTA - S Weeping Lovegrass	Woodward, OK, and Temple, TX	OK, TX	2/76	B

PUBLICATIONS:

(Listed alphabetically by first ARS author, where coauthored by non-ARS person, without regard to Technological Objective. ARS authors underlined.)

Asay, K. H., and D. R. Dewey. 1975. Fertility trends in colchicine-induced Triticeae amphiploids. Proc. Grass Breeders Conf. 23:55.

Barker, R. E., J. J. Bond and L. G. Zachmeier. 1976. Equipment for seeding experimental plots of small grains, grasses, and legumes. Agron. J. 68:141-142.

Barker, R. E., and A. B. Frank. 1975. Variation in photosynthesis and water use in three wheatgrass species. Twenty-third Grass Breeders Work Planning Conf. Proc., pp. 52-54, Sept. 9-11, St. Paul, MN.

Bashaw, E. C. 1975. Problems and possibilities of apomixis in the improvement of tropical forage grasses. In: "Tropical forages in livestock production systems." Am. Soc. Agron. Spec. Publ. 24:23-30.

Dewald, C. L., and E. H. McIlvain. 1975. Forage fed 700-pound weaner calves today--1000-pound weaners by 1980. Proc. Forage and Livestock Conf. The Noble Foundation, Ardmore, OK. August 7, 1975.

Dewey, D. R. 1975. Genome relations of diploid Agropyron libanoticum with diploid and autotetraploid Agropyron stipifolium. Bot. Gaz. 136:116-121.

Dewey, D. R. 1975. Introgression between Agropyron dasystachyum and A. trachycaulum. Bot. Gaz. 136:122-128.

Dewey, D. R. 1975. The origin of Agropyron smithii. Am. J. Bot. 62:524-530.

Dewey, D. R., and K. H. Asay. 1975. The Crested Wheatgrasses of Iran. Crop Sci. 15:844-849.

Eckert, Richard E., Jr. 1975. Improvement of mountain meadows in Nevada. USDA/BLM Res. Report (Filing Code 4400). 45 pp.

Blackburn, W. H., R. E. Eckert, Jr., M. K. Wood, and F. F. Peterson. 1975. Influence of vesicular horizons on watershed management. Proc. ASCE Watershed Management Symposium, Utah State Univ., Logan, UT. pp. 494-515.

Fairbourn, M. L. 1975. Field evaluation of microwatershed and vertical mulch systems. Proc. Water Harv. Symp., Phoenix, AZ, Mar. 26-28, 1974. ARS W-22:233-243.

Fairbourn, M. L., and H. R. Gardner. 1975. Water-repellent soil clods and pellets as mulch. *Agron. J.* 67:377-380.

Frank, A. B., and R. E. Barker. 1976. Rates of photosynthesis and transpiration and diffusive resistance of six grasses grown under controlled conditions. *Agron. J.* 68:487-490.

Gomm, F. B., and H. A. Turner. 1976. Build flexibility with irrigated pasture. *Western Farmer* 53:16-18.

Hart, R. H., and G. E. Carlson. 1975. Agricultural implications of climatic change. *Agronomic implications: Forages.* CIAP Monogr. 5, *Impacts of Climatic Change on the Biosphere, Pt. 1, Climatic Effects.* USDOT Rep. No. DOT-TST-75-55:4-163--4-173.

Campbell, R. S., and C. H. Herbel, eds. 1975. Improved range plants. Range Symp. Series No. 1, Soc. Range Manage., Denver, CO. 96 pp.

Houston, W. R., and D. H. van der Sluijs. 1975. S-triazine herbicides combined with nitrogen fertilizer for increasing protein on shortgrass range. *J. Range Manage.* 28:372-376.

Houston, W. R., and D. N. Hyder. 1976. Controlling sixweeks fescue on shortgrass range. *J. Range Manage.* 29:151-153.

Lang, R., F. Rauzi, W. Seamands, and G. S. Howard. 1975. Guidelines for seeding dryland range, pasture and disturbed lands. *Wyoming Agr. Exp. Sta. Bul.* B-621.

Hyder, D. N., W. R. Houston, and J. B. Burwell. 1975. Tally equipment for frequency sampling of herbaceous vegetation. *USDA-ARS-W Unnumbered Series.* 21 pp.

Hyder, D. N., W. R. Houston, and J. B. Burwell. 1976. Drought resistance of blue grama as affected by atrazine and N fertilizer. *J. Range Manage.* 29:214-216.

Lavin, F., and T. N. Johnsen, Jr. 1975. Forage shrub adaptation trials at three Pinyon-Juniper sites. *ARS W-29, August 1975.* 5 pp.

Lorenz, Russell J. 1976. Resource combination and technological innovations for beef cattle enterprises in the northern Great Plains. pp. 37-52. *In Symposium Proc., Integration of Resources for Beef Cattle Production, SRM-AFGC-ASAS-ASA, Omaha, NE, February 16-20, 1976.*

Morrow, L. A., and M. K. McCarty. 1975. Control of green sagewort in the Nebraska sandhills. *Weed Sci.* 23:465-469.

- Morrow, L. A., and M. K. McCarty. 1976. Effect of weed control on forage production in the Nebraska sandhills. J. Range Manage. 29:140-143.
- Shoop, M. C., and D. N. Hyder. 1976. Growth of replacement heifers on shortgrass ranges of Colorado. J. Range Manage. 29:4-8.
- Shoop, M. C., E. H. McIlvain, and P. W. Voigt. 1976. Morpa weeping lovegrass produces more beef. J. Range Manage. 29:101-103.
- Shoop, M. C., E. H. McIlvain, and P. W. Voigt. 1976. Morpa weeping lovegrass produces more beef. J. Range Manage. 29(2):101-103.
- Sneva, F. A., V. E. Hunter, and L. R. Rittenhouse. 1975. Summer grazing performance of cattle as influenced by water stress and trailing. Proc. Western Sec., Amer. Soc. Anim. Sci. 26:27-28.
- Townsend, C. E. 1975. General and specific combining ability for several agronomic traits in diallel cross progenis of Cicer milkvetch. Crop Sci. 15:341-343.
- Townsend, C. E., and W. D. Ackerman. 1975. Variability for vigor, height, and flowering in introductions of Cicer milkvetch. Can. J. Plant Sci. 55:843-845.
- Townsend, C. E., G. O. Hinze, W. D. Ackerman, and E. E. Remmenga. 1975. Evaluation of forage legumes for rangelands of the Central Great Plains. Colo. State Univ. Exp. Sta. Gen. Ser. 942. 10 pp.
- McConnell, R. L., and C. E. Townsend. 1975. Inheritance of a chlorophyll deficiency in diploid Alsike clover. Crop Sci. 15:583-584.
- Voigt, P. W. 1975. Effect of fall mowing on winter survival of lovegrass strains. Crop Sci. 15:574-577.
- Voigt, P. W. 1975. Improving palatability of range plants. pp. 23-49. In R. S. Campbell and C. H. Herbel [ed.] Improved range plants. Range Symp. Series No. 1. Soc. Range Manage., Denver, CO.
- Voigt, P. W. 1975. Selection for winter survival ability. Proc. Grass Breed. Work Plan Conf. 23:49-50.
- Voigt, P. W., W. R. Kneebone, J. R. Harlan, and R. M. Ahring. 1975. Registration of Texoka buffalograss. Crop Sci. 15:885.
- Wright, L. N. 1975. Improving range grasses for germination and seedling establishment under stress environments. In: Improved Range Plants, Soc. Range Manage., Range Symposium Ser. No. 1:3-22.

Abernethy, R. H., and L. N. Wright. 1975. Inflorescence gas exchange and seed weight of blue panicgrass. Crop Sci. 15:383-384.

Stalker, H. T., and L. N. Wright. 1975. Reproduction of Eragrostic curvula (Schrad.) Nees. J. Arizona Acad. Sci. 10:106-110.

Wood, M. K., R. W. Knight, and J. A. Young. 1976. Spiny hopsage germination. J. Range Manage. 29:53-56.

NRP Annual Report
FY 1976

NRP 20160 Plant Germplasm (Introduction, Evaluation, and Maintenance)

NPS Contact: Q. Jones

PACS Contact: L. L. Jansen

MISSION: Provide plant germplasm and information on its taxonomic relationships and use potential necessary for promoting efficiency in crop agriculture.

TO 1. Expanded collections and improved maintenance, evaluation, and distribution of plant germplasm as sources of useful genetic material to improve existing crops and developing new crops.

Germplasm Resources Laboratory, Beltsville, MD

The 13,725 seed and plant introductions in 1975 included 5,435 small grain cereals (3,945 rice), 4,588 vegetables, 1,754 forages, 1,254 oilseed, 236 ornamentals, 143 sugar, 91 fruit, 84 tobacco, 58 cotton and fiber, and 82 specialty crops. Sixteen hundred and four seed shipments to 104 countries included 70,364 exchange items.

New accessions to the Small Grains Collection totaled 2,698 (1,984 foreign, 714 domestic). Plant scientists received 102,550 packets of seed from the collection. There were 34,417 samples sent in 229 foreign shipments and 68,133 samples sent in 250 domestic shipments.

Resistance in spinach to Fusarium oxysporum f. sp. spinaciae was found in 10 P.I.'s out of the 60 tested lines. P.I. 317425 from Korea was the most disease-resistant in all tests; P.I. 175926 from Turkey was the best at 24°C.

An inventory of the USDA rice collection was completed, computerized, and distributed to rice researchers worldwide.

National Seed Storage Laboratory, Fort Collins, CO

During 1975 new accessions totaling 2,519 were added to the inventory. Of these, 621 were fruit and vegetable and 1,898 were field crop samples. Total accessions now number 91,274. Samples distributed during 1975 were 105 fruit and vegetable accessions to 15 scientists and 619 field crop accessions to 37 scientists.

TO 1 (Cont'd)

All of the basic records for the germplasm collection, such as genus, species, cultivar name, accession number, donor, germination history, storage location, amount of seed, etc., have been converted from a manual to an ADP records system.

Plant characteristics for 1,158 guar (Cyamopsis tetragonoloba (L.) Taub.) and 2,927 bean (Phaseolus vulgaris L.) accessions have also been entered into the data bank.

Reed canarygrass seeds stored at -12, -1, and 5°C showed little or no decline in viability after 12 years, but seeds at 10°C showed a viability decline of one-half to two-thirds or more.

Isogenic lines of pearl millet (Pennisetum typhoides (Burm.) Stapf and Hubbard) containing chlorophyll deficiency mutant genes were aged at 32°C and 90% relative humidity to reduce viability by 50%. Seedling populations from control and deteriorated samples showed no differences for the mutant genes.

North Central Regional Plant Introduction Station, Ames, IA

New agronomic, horticultural, and industrial plant introductions received in 1975 totaled 617, including ornamentals. This included 80 accessions of corn from Yugoslavia received through the PL 480 project. There are now more than 20,000 accessions in the collection.

In 1975 more than 3,100 accessions were grown for seed increase and revitalization.

Plant material distributed amounted to more than 11,000 items of seed packets and plants.

The alfalfa variety 'Deseret', jointly released by the Utah AES and ARS, is a selection out of P.I. 279958 from Kayseri, Turkey. The variety has good resistance to stem nematode, downy mildew, and bacterial wilt.

'Flintlock' western wheatgrass, jointly released by the Nebraska AES and ARS, is a product of selections from 30 collections made in 1957 from natural grasslands of central and southwestern Nebraska and northwestern Kansas under a domestic plant exploration project.

TO 1 (Cont'd)

'Petite' tickbean (Vicia faba L.), a selection from P.I. 222129, Afghanistan, was released by the Minnesota AES.

Northeastern Regional Plant Introduction Station, Geneva, NY

Development of hybrid cucumbers made possible by P.I. 220860. Nearly half of the cucumber varieties offered for sale are hybrids with one parent a plant introduction selection discovered at the Northeastern Regional Plant Introduction Station. This cucumber introduction produces only female flowers, making it extremely useful as the female parent in producing commercial cucumber hybrids.

Southern Regional Plant Introduction Station, Experiment, GA

Seed or plants of 4,678 new plant introductions were received, increasing the inventory of germplasm being maintained to more than 33,000 accessions. A collection of 4,177 pigeonpea introductions from Iran and 395 mungbean accessions introduced from many countries by the University of Missouri accounted for a high percentage of the new material. Thirty-one hundred introductions representing numerous crop species were grown for seed increase and preliminary evaluation of agronomic and horticultural characteristics. Introductions of Paspalum alcalinum from Paraguay and P. jurgensii from Brazil showed good potential for forage production in the lower South. A 3-year study of the winter hardiness of Digitaria and Hemarthria introductions was completed. Fifty-four Digitaria accessions that are outstanding for cold tolerance, insect resistance, or drought tolerance have been identified.

Catalogs listing available introductions of edible legumes, Solanum, and winter legumes were updated to include the most recent introductions.

Distribution of 16,234 packets of seed and plants was made to plant scientists for further evaluation and use in plant breeding programs. A survey of plant material needs by plant breeders resulted in six formal requests for foreign plant explorations.

Western Regional Plant Introduction Station, Pullman, WA

Seed harvest and evaluation of 1,438 accessions of agronomic introduction was completed, and fresh seed of 615 introductions from many genera were sent to the National Seed Storage Laboratory for permanent storage.

Carthamus tinctorius accessions P.I. 388901, 388902, and 388903 from Iran remained in the rosette almost a month longer than other safflower accessions and may have important genes for winter habit.

TO 1 (Cont'd)

The data collected on all agronomic introductions are now completely entered into the TAXIR computer system, and a completely updated, annotated inventory of all agronomic seed stocks will be published soon.

During the first 10 months of FY 1976, distribution of 5,329 agronomic introductions were made to requesting scientists.

Subartic Agricultural Research, Palmer, AK

A forage test (4 cuts/yr) involving 17 bluegrass entries (11 experimental selections) and 9 red fescues (4 experimental selections) in broadcast plots identified one extraordinarily early bluegrass that also possesses outstanding winterhardiness. Forage dry-matter yields of 4 experimental bluegrasses surpasses 4 T/A, more than twice the yields of the taller growing Polar brome and Engmo timothy, included as checks, that are less tolerant of frequent harvest.

After 20 harvest years in four large field experiments (harvested two times per year), top forage yielders were Nugget Kentucky bluegrass and Arctared red fescue, followed closely by Garrison creeping foxtail, Polar brome, and two native Alaskan grasses: arctic wheatgrass (Agropyron macrourum), and arctic brome (Bromus pumpellianus). The native wheatgrass and brome represent relatively unselected bulk lots, suggesting that further selection should identify biotypes of even greater promise for forage production.

Subtropical Horticulture Research Station, Miami, FL

Ornamental plant material of approximately 75 species were distributed in the form of seeds, plants, or foliage to over 200 nurseries or institutions. About 350 plants of Erythrina fusca 'Fastigiata', P.I. 233848, were distributed for use as a windbreak and as an ornamental species for tropical and subtropical areas.

One mango selection has ripened fruit earlier than all other cultivars for 3 consecutive years. Industry representatives consider fruit quality of this selection acceptable.

Institute of Tropical Agriculture, Mayaguez, PR

A small but cosmopolitan collection of winged beans (Psophocarpus tetragonolobus) was obtained and observed during two seasons. High yielding, rain-resistant varieties were selected.

One sweet corn population, highly resistant to major foliar diseases and pests, will be released.

- TO 2. New and improved knowledge of the chemical, biological, and agronomic potentials of selected plant species as new crop sources of industrial oils, waxes, gums, fibers, of food and feed proteins, and licit and illicit narcotic drugs and other medicinals.

U.S. Plant Introduction Station, Savannah, GA

Root-knot nematode larval populations, measured biweekly, were suppressed by roselle and resistant kenaf as compared with susceptible kenaf.

Plant populations of roselle and resistant kenaf, ranging from 99 to 396 thousand plants per hectare, produced greater bark to core ratios with increasing population. Roselle was lower in bark/core ratio than kenaf, but the root-knot resistant kenaf lines were not different from normal kenaf.

Three nematocides were tested with resistant kenaf, susceptible kenaf, and roselle against field populations of two species of root-knot nematodes. In the Meloidogyne arenaria test EDB produced satisfactory results, while DBCP was better than the check but unsatisfactory and Carbofuran was not different from the check.

Chinese waterchestnut plants were successfully grown from seed. Germination percentage was low and germination much delayed (about 6 weeks). Plants grown from seed produced corms. A modified potato digging machine successfully harvested corms from both sandy soil and pure sand. Excessive plant density appears to reduce corm size but not yield.

Horticultural and Special Crops Laboratory, Peoria, IL

Chemical, spectroscopic, and chromatographic screening for unusual seed oil constituents was conducted on 335 new samples.

Gasliquid and thin-layer chromatographic analysis of 55 oils revealed a number of oils with unusual fatty acid composition. Two of these oils, Crepis conyzaefolia and Alchornea cordifolia, were studied in depth by mass spectrometry, ozonolysisGLC, and other characterizational techniques. Two new epoxy acids were found in major amounts in C. conyzaefolia and one in A. cordifolia.

Methods development, for present and future needs, continues to be an important aspect of the work. A new procedure, which employs high-performance chromatography, separates triglycerides by size, number of double bonds, and functional groups, providing detailed information on triglyceride structure and composition of seed oils.

TO 2 (Cont'd)

Medicinal Plant Resources Laboratory, Beltsville, MD

Screening of plant samples for antitumor activity in FY 1976 yielded 160 new active species.

A major procurement operation was conducted in Taiwan to obtain 12,000 pounds of roots of Tripterygium wilfordii, source of a new anticancer agent - "triptolide" urgently needed for preclinical and clinical evaluation.

A field study was conducted in Kenya to locate an additional supply of Maytenus buchananii; 20,000 to 50,000 pounds will be required to supply an adequate amount of the new drug maytansine to permit expansion of the current clinical evaluation now underway.

Institute of Tropical Agriculture, Mayaguez, PR

New techniques were developed to extract protein from the juices from leaves. Controlled heat is used to precipitate a green protein concentrate. Then the liquid residue is treated with acetone to precipitate a white protein suitable for human consumption. The process can be extended commercially.

TO 3: Increased understanding of the taxonomic relationships, geographical and ecological distribution, and centers of diversity of crop plants and their wild relatives to promote the systematic assembly of germplasm for crop improvement.

Plant Taxonomy Laboratory, Beltsville, MD

Preliminary information on centers of diversity was integrated with more advanced information on ecological and geographic distribution of crop plants and their relatives (1000 species) so that their ecological amplitudes and centers of diversity could be compared instantly. Such information is useful in assembling germplasm for crop improvement. Germplasm showing some promise for iron-efficient sorghum was acquired as a direct result of this information bank.

Medicinal Plant Resources Laboratory, Beltsville, MD

An intensive study of the distribution of antitumor activity in higher plants identified particular families, orders and subclasses that hold the most potential as sources of anticancer drugs. Another study suggested that plants used for medicinal purposes in folklore are twice as likely to contain antitumor agents as plants selected at random.

TO 3 (Cont'd)

U.S. National Arboretum, Washington, DC

A taxonomic world monograph of the wild and cultivated Koelreuteria was completed and accepted for publication.

Sinoradlkofera, a new genus of flowering plants, was discovered in the course of the taxonomic study of the genus Koelreuteria and represents a unique tree species limited to two provinces in south China.

Publications:

- Bagby, M. O., T. F. Clark, W. C. Adamson, and G. A. White. Kenaf stem yield and composition: Influence of maturity and field storage. TAPPI CA Rpt. 58:57-60. 1975.
- Bass, L. N. Seed moisture and storage. Seed Sci. Technol. 3:743-746. 1975.
- Clark, D. C., and L. N. Bass. Effects of storage conditions, packaging materials and moisture content on longevity of crimson clover seeds. Crop Sci. 15:577-580. 1975.
- Craddock, J. C., H. I. Owens, and F. E. Wesbrook. Wheat cultivar description handbook. U.S. Dept. Agr. 90 pp. 1976.
- Dudley, T. R. How to name, register, and patent selected cultivars of amenity plants. Proc. First Symposium on Better Trees for Metropolitan Landscapes. U.S. Forest Service (in press).
- Fogle, H. W. and H. F. Winters. Progress in computerization of a national fruit germplasm resources inventory. (Abstr.) Hort. Sci. 1975.
- Hyland, H. L. Recent plant explorations in the USA. Crop Genetic Resources for Today and Tomorrow. Cambridge Univ. Press 139-146. 1975.
- Knight, R. J., Jr. Special problems in tropical fruit production. Proc. XIX Internl. Hort. Congress (Warsaw, Poland): 59-68. 1975.
- Meyer, F. G. A revision of the genus Koelreuteria Laxmann (Sapindaceae). Jr. Arnold Arboretum. 57(2). 1976.
- Roos, E. E., and J. R. Manalo. Effect of initial seed moisture on snap bean emergence from cold soil. J. Am. Soc. Hort. Sci. 101:321-324. 1976.

Honors and Awards:

Dr. J. C. Craddock selected by the International Board for Plant Genetic Resources to serve on the International Wheat Advisory Committee.

H. L. Hyland received USDA Superior Service Award "For significant contributions in the introduction and exchange of valuable plant germplasm for use in crop improvement programs throughout the world."

NRP Annual Report
FY 1976

NRP 20170 Physiological and Biochemical Technology to Improve Crop
Production

NPS Contact: G. G. Still

PACS Contact: L. L. Jansen

Examples of Progress:

TO 1: Improve biological conversion of solar energy for increased crop production by increasing the efficiency of photosynthesis, translocation, and associated metabolism.

Beltsville, MD (Light and Plant Growth Laboratory, PPhI): Differences in source-sink relationship have been suggested between sugarbeet and soybean on the basis of contrasting CO₂ exchange rate (CER) patterns following 11 to 14 hours of illumination. CER of sugarbeet remains relatively constant while that of soybean declines significantly. Further study will elucidate why sugarbeet maintains a constant CER while soybean does not.

Procedures have been developed for measuring photosynthesis and photorespiration of intact leaves of tobacco. Leaf chambers have been developed and growing conditions are being established for tobacco seedlings of John Williams Boradleaf, su/su, and Su/su genotypes. Light intensity alters the expression of leaf coloration.

Sugarbeet populations have been identified that differ in partitioning of photosynthate. Two cycles of selection altered the proportion of taproot-hypocotyl to leaf blade weight of two groups of sugarbeet progenies by 65 percent 21 days after emergence of the seedlings. This indicates that partitioning of photosynthate in sugarbeet has a strong genetic component. The differential was detectable 15 days after emergence.

A system that accurately controls and predicts temperature of tissue in a culture flask was developed. Flasks containing agar and tissue of tobacco were placed on a metal plate inside a plastic chamber. Temperature of plate and chamber air were controlled separately. Temperature of the plate, the chamber air, agar, tissue, and flask air were monitored. Temperatures of the plate and chamber were varied in 10F increments for all combinations from 40 to 90F for 0, 500, 1000, and 2000 ft-c of irradiance. Mathematical expressions were derived to describe the condition of the tissue for both the stable and unstable conditions. The coefficient of correlation, r , for the stable and unstable conditions are 0.98 and 0.99, respectively.

Mississippi State, MS (Cotton Production Research Unit): The rates of respiration and photosynthetic O_2 evolution were determined on cotyledons during aging. The rates decline on a unit area basis. Full photosynthetic activity is completed after 24 hours of full sunlight in normal seedlings. However, etiolation, as sometimes occurs in adverse weather during emergence, reduces the rate that the photosynthetic apparatus develops in the cell, and such seedlings sometimes fail to ever reach full potential.

Cotton and other C-3 and C-4 species were grown in 300 and 600 ppm CO_2 atmospheres at the Western Cotton Laboratory facility during May and June, 1975. Photosynthetic rates and starch-sugar concentrations in the leaves were determined. Increased starch level decreased the rate of photosynthesis, but the response was variable among species. Record starch and sugar values were obtained at the 600 ppm CO_2 level, and values for tomatoes doubled those previously reported.

Peoria, IL (Northern Regional Research Center): Methodological advances characterize the progress of the past year. A dual dye tunable laser system pumped by an Argon laser has been acquired. This state of the art equipment gives intensities of monochromatic light higher than sunlight and is variable throughout the visible range of the spectrum. It will be used in lieu of and with great advantage over the mercury filter sources described last year.

Nitzschia closterium (a brown diatom) and Chlorella pyrenoidosa (a green alga) are now cultured on agar slants, as suspension in 250-ml. flasks and on continuous (2 liter) scale. Other species of Chlorophyceae, Pheophyceae, Rhodophyceae, and Myxophyceae are being studied for similar levels of culture.

High-performance liquid chromatography of reversed phase type on Corosil-C18 has been studied and successfully carried out on pigments of algae and higher plants. This procedure gives quantitative separation and recoveries of pigments and permits accurate calculation of light absorption by pigments of various plant and algal species.

Mass spectrometric equipment needed for measuring oxygen and carbon dioxide and for stable isotopes of oxygen and carbon ($^{13}\text{O}_2$) has been acquired and space adjacent to irradiation areas for higher plants has been cleared.

Yellow isolines of Harosoy and Clark soybean varieties have been obtained from Dr. R. Bernard, U.S. Regional Soybean Laboratory, and grown for pigment studies, particularly for carotenoid analysis by high-performance liquid chromatography.

Athens, GA (Horticultural Crops Utilization and Marketing Laboratory):

Appropriate laboratory equipment has been ordered to enable biochemical and physiological characterization of photosynthesis in various plant species. The University of Georgia has made their facilities available, thereby permitting the acquisition of the necessary skills to establish an effective physiological and biochemical photosynthesis program. Primary interests focus on searching for intermediate C_3 - C_4 plant species by determining CO_2 compensation values, CO_2 fixation under normal and low oxygen and anatomical features. Coupled with the research will be studied to locate photosynthetic enzymes intracellularly.

TO 2: Improve nitrogen fixation efficiency of bacteria-plant associations and develop nitrogen-fixing capabilities in crops lacking this capability in order to reduce energy requirements for crop production.

Peoria, IL (Northern Regional Research Center): Studies of the nitrogenous pools in algae-containing and algae-free plants have revealed the presence of very high levels of free ammonia in nitrogen-fixing plants which contain blue-green algae. In addition, the unusual amino acid cystathionine has been found to be present in high concentration in this fern.

Photoproduction of molecular hydrogen by the nitrogenase complex has been studied in intact ferns, plant extracts, and in free-living algae in a continuous hydrogen generator. Rates of hydrogen production have ranged from 1 to 20 micromoles per hour per gram depending on the biological material used.

In further studies of the nitrogen-fixing symbiosis in the water fern Azolla and its associated blue-green alga, we have identified two bacteria found associated with the algae as Alcaligenes faecalis and Caulobacter sp. Work is continuing toward axenic culture of the symbiont and the relationship of the various organisms to the symbiosis.

Beltsville, MD (Cell Culture and Nitrogen Fixation Laboratory, PPhI):

Nitrogen (N₂) fixation by a temperate corn-Spirillum association was demonstrated. The corn-bacterial association is similar to associations reported in tropical areas. A temperate Spirillum with properties similar to the tropical Spirillum was isolated. Spirillum characteristics are ability to utilize organic acids, microaerophilic N₂ fixing activity, gram negative, respiratory type of metabolism, inability to oxidize or ferment common carbohydrates, motile, and mol percent guanine plus cytosine 71 (tropical Spirillum mol % G + C 69-70). Significant nitrogenase activity was observed for selected root portions from a commercial corn var. Funks G-4646 at several Beltsville Agricultural Research Center fields. Contribution of fixed nitrogen to corn plants was low and estimated to be 0.1 kg N/ha/day. High nitrogen fertilizer rates at planting may have inhibited activity.

TO 3: Develop new and improved cell and tissue culture technology for plant improvement through increased genetic diversity and rapid vegetative propagation.

Peoria, IL (Northern Regional Research Center): The Japanese plum yew, Cephalotaxus harringtonia, is a source of promising anti-tumor alkaloid-esters. Sections of needles and stems from a young plant were surface sterilized with HgCl₂ and callused on White, Murashiga, and Skoog (MS) culture media with various organic supplements. Best growth was obtained with MS, 3 percent sucrose, 1 g/l. protein hydrolysate, 0.1 mg./l. B₁, 0.5 mg./l. B₂ and niacin, 10 mg./l. NAA, 1 mg./l. kinetin and 1 percent agar. GC-MS demonstrated the presence in callus extracts of the anti-tumor alkaloid-ester, deoxyharringtonine, together with its unesterified alkaloid precursor, cephalotaxine, and related homoerythrina alkaloids. Compounds with GC retention times of isoharringtonine, harringtonine, and homoharringtonine (other active alkaloid-esters) were present, but in insufficient amounts to permit their positive identification in this preliminary test.

Beltsville, MD (Cell Culture and Nitrogen Fixation Laboratory, PPhI)

Requirements for the culture and regeneration of garlic apices were essentially completed: The auxin and cytokinin requirements were identified and whole plants were regenerated. Haploids of rice were obtained from anther tissue, tissues increased and plantlets then regenerated. Soybean anther tissues (although not necessarily haploids) grew well in vitro and were shifted with selected media to extensive root development. The quality of the tissues was assessed quantitatively by reflectance microscopy. Initial proof for feasibility of biochemical cell selection with amino acid analogs was obtained with tobacco. Quantitative analysis showed that cells selected had up to 40 times the glutamic acid content of the controls. Other amino acids were higher as well. Plants from 15 selections were regenerated from allus, seeds were collected, and progeny reseeded for further quantitation. Exogenous amino acids did not repair the tobacco mutant, SuSu. Methionine was inhibitory and auto-claved cysteine prevented leaf development. It was further shown that SuSu tissues grew profusely as cell suspensions when cultured in presence of 2,4-D and that leaf tissue may again be regenerated from resulting cells.

At least one kanamycin-resistant line of tobacco was derived by selection of cultured cells. Plants were regenerated and are being grown to obtain seed for genetic analysis. Protoplast isolation and culture conditions have been found which stimulate a high proportion (75%) of protoplasts derived from cell suspension cultures of tobacco to regenerate cell walls and a reasonable proportion (20%) to undergo division.

Male-sterile lines of barley were examined for cytological or histological differences in the time or mode of pollen breakdown. Plantlets from male-sterile tobacco anthers on tissue culture were haploids and diploids. The pollen grains therefore appear capable of growth when young anthers are used. Diploid plantlets grown from tissue culture proved to be male sterile. A barley stock with 15 and 16 chromosomes instead of the normal 14 was studied to determine the stability of the extra chromosome(s). Plants from different generations were examined for the frequency of the extra chromosomes. Abnormalities in the length of chromosomes or other abnormal cytological events were noted.

Nearly all cultivars of carrot required 2 to 3 months in culture before attaining embryogenic competence. Cells from most cultivars maintained competence for 2 to 3 subcultures (60 to 90 days) after which they lost the capacity to form somatic embryos. Carrot roots stored in the cold for as long as 60 days yielded cells with embryogenic competence.

After 60 days in cold storage some cultivars lost capacity to differentiate even though the isolated cells grew well; those cultivars which still formed somatic embryos did so at a diminished rate. Neither SM-3 (a cytokinin fortified seaweed extract) nor the cytokinin benzyladenine were as effective as 2,4-dichlorophenoxyacetic acid in relieving Ca^{++} induced Fe^{+++} stress symptoms in soybeans. Cells from 4 carrot cultivars were grown on 4 levels of nalidixic acid (an inhibitor of circular DNA synthesis) in order to develop cell lines free of chloroplast DNA, for transformation studies where foreign chloroplast DNA will be the information vector. Bleached cells were selected and induced to form plantlets. One culture yielded plants (none of which appear morphogenically normal) which are devoid of yellow or green pigments. It is not yet known whether these plants are free of chloroplast DNA. Tobacco and carrot cells which initially grew (and thrived) in the presence of *Agrobacterium rhizogenes* survived only one transfer before succumbing to bacterial infection. Several anions and cations were assayed for their ability to alter the root promoting activity of 2,4-dinitrophenol (an uncoupler of oxidative phosphorylation). None of the ions tested enhanced the activity of DNP but some did reduce its effectiveness. Substitutions in positions 1, 2 and 4 of the ring resulted in loss of activity of the phenol. 2,6-DNP was also found to promote root formation. Two new compounds both of which interfere with the flow of electrons or H^+ in the respiratory chain were found to have significant root promoting activity. They are sodium amytal and phenazine-methosulfate.

Galactose, a sugar with growth regulator like properties and a stimulator of ethylene production, inhibited the translocation of IAA in plant tissue. The growth regulation effect of galactose may be the result of its inhibition of auxin movement, which in turn stimulate ethylene synthesis which causes changes in the direction of growth. Galactose and other sugars which interfered with the translocation of auxin were assessed for their ability to influence root initiation in the mung bean assay. Both galactose and mannose were found to stimulate root primordia initiation. The galactose effect appears to be independent of its effect on the production of ethylene gas because ethylene in several forms and concentrations did not enhance root production. Asparagus tissue from a supermale plant with demonstrated fusarium tolerance has finally, after 6 months, given rise to callus, which will be used in an attempt to regenerate large numbers of fusarium tolerant supermale plants for use in the New Jersey asparagus breeding program.

TO 4: Develop technology for improving the absorption, translocation, and utilization of nutrients and water to increase crop production efficiency.

Activities under this technical objective are being implemented. This research is presently being conducted in part under NRP's 20780, 20790, 20010, 20100, 20730, 20760, and 20770.

TO 5: Improve technology for better crop production under environmental stress.

Beltsville, MD (Plant Stress Laboratory, PPhI): Effect of UV-B radiation (280-320 nm) on vegetative growth and reproduction under greenhouse and growth chamber conditions. Broad band UV-B radiation was produced by FS-40 sunlamps filtered with mylar to produce only UV-A (above 320 nm) or with cellulose acetate to produce UV-A and B (greater than 280 nm). Dosage of UV was a function of time and/or distance from the radiation source. Levels of UV-B radiation were determined by a Robertson-Berger Sun Meter or a Gamma Spectroradiometer using a solar blind phototube.

Under growth conditions, Alaska pea was extremely sensitive to UV-B; Poinsett cucumber and Small Fry tomato were moderately sensitive. Wando pea was only slightly sensitive; Sparkle pea and Cherry Belle radish were essentially unaffected. Chico peanut was resistant to UV-B injury. Grand Rapids lettuce failed to show consistent symptoms of injury.

Threshold studies with Alaska pea in growth chambers at three levels of UV-B radiation under low and high visible light provided the first evidence of photoreversal of UV injury. UV injury was much greater under low, visible light ($160 \mu\text{EM}^{-2}\text{sec}^{-1}$) than at high light levels ($320 \mu\text{EM}^{-2}\text{sec}^{-1}$).

Greenhouse broad band UV-B studies were conducted on the following crops: wheat (cultivars #14590, dwarf, 13100 Normal and 14588 Normal from the National Wheat collection), cotton (Deltapine SL) and Chico variety peanut.

Two Browallia varieties showed severe leaf crinkling and growth reduction under UV-B; boll development was slightly delayed in cotton; tillering appeared to be reduced in certain wheat selections; Wando pea and Chico peanut were visibly unaffected by UV-B treatment in the greenhouse.

Cooperative studies with Dr. Robert Stewart provided the first evidence for the formation of a UV-B degradation product in the epidermis of Coleus blumei that fluoresced yellow after only 6 hours of exposure to UV-B irradiation. Under cellulose acetate this pigment was found chiefly in the epidermal hairs appearing as a crystalline material in visible light in those portions of the cells where the anthocyanin had been destroyed. In contrast, under unfiltered FS-40 lamps this pigment was prevalent along the entire epidermis within 6 hours of exposure.

Comparative radiation measurements were taken in plant growth chambers. These studies demonstrated the problems involved in providing uniform radiation levels in separate controlled environment facilities.

Significant variations in total radiant energy were obtained among these facilities even though the same level of photosynthetically active radiation (PAR) was used. Measurements of light under cool white fluorescent and incandescent lamps with calibrated photometers from different manufacturers varied by as much as 20 percent.

Differences in the amount of incandescent radiation in different facilities provided one of the chief sources of variation. This difference was only evident by using a specially built far-red sensor made by Lambda Instrument Company for use by committee members. It has since been built and distributed as a standard shelf item.

Factors were calculated for interconversion between quantum, photometric, and radiometric measurements, but high precision cannot be assured when using these factors because of differences in instrument sensitivity and variations in spectral output of different lamps.

These findings document the critical need for greater care in obtaining and reporting radiation data in controlled environment studies, the need for calibrating radiation instruments under the same type of light source that is used in the growth chamber, and for the use of several types of instruments in order to properly characterize the quality and quantity of radiation controlling plant growth and development.

Water stress, radiation stress, and atmospheric stress were identified as the three major stresses commonly experienced by plants in controlled environment chambers. Techniques are being developed and evaluated for overcoming these limiting factors, through use of automatic watering systems, plexiglass barriers to remove UV radiation, and adequate atmosphere control.

Interrelation of environmental stress and plant disease incidence: Tests were run to determine the effect of boron (B) on susceptibility of tomato to Fusarium wilt and to Verticillium wilt. Boron up to 75 ppm had no visible effect on mycelial growth. In nutrient culture, B was not toxic to tomato seedlings up to 1 ppm, but was at 10 ppm. Stunting and leaf necrosis occurred at 30 and 50 ppm. Boron at these levels did not have a significant effect on tomato susceptibility to the two wilts. Ultraviolet light in the 280-320 nm range did not significantly reduce lettuce growth, but did slightly reduce anthracnose disease severity. Tests are in progress on the effects of UV on severity of the tomato pathogen, *Alternaria solani*. Endomycorrhizae, associated with roots of most crop plants, increased the uptake of P. In a high Al soil without lime (pH 4.2) and with a high rate of lime (pH 7.2), endomycorrhizae had little effect on growth of wheat. In the same soil limed just enough to reduce Al toxicity (pH 5.5), mycorrhizae significantly increased plant growth.

Isolates of Verticillium dahliae from western Texas (but not from other U.S. and foreign areas) were pathogenic to alfalfa in the greenhouse. Disease severity was greater in steamed soil than in alfalfa field soil. Alfalfa plants were screened for resistance to *Mycoleptodiscus* crown and root rot, and others to *Fusarium* wilt. The survivors (approximately 2 percent) were crossed for a second cycle of selection. Using a petri dish method for growing alfalfa seedlings on agar seeded with *Rhizoctonia solani*, approximately 3 percent survived and appeared to be resistant. Tolerant and susceptible cultivars of alfalfa were inoculated with *Fusarium oxysporum* f. *medicaginis* from California, Maryland, and Minnesota. The isolates varied in pathogenicity and the cultivars in susceptibility, but races of the fungus were not detected.

Seventeen Kentucky bluegrass, Poa protensis, cultivars were evaluated for sensitivity to ozone, and to sulfur dioxide. Treatments were 40 pphm ozone, or 20 pphm sulfur dioxide for 2 hours at 26C, 92 percent relative humidity and illumination of 21,500 lux. Cultivars differed significantly in sensitivity to both phytotoxicants. The range in sensitivity among cultivars was not as

great for SO₂ as for O₃. Cultivar response differences to both O₃ and SO₂ injury were sufficiently consistent to indicate genetic differences within this species. Several cultivars had practical levels of resistance.

Mississippi State, MS (Cotton Production Research Unit): Premature leaf senescence in early season cotton reduces yield and quality. Field experimentation using different levels of nitrogen and potassium, and variations in stand density was performed to determine effect on senescence. Plants in plots receiving heavier and/or timed applications of nitrogen and potassium still cut-out or became senescent before all of the crop was mature.

Thinning from a stand density of 100,000 to 250,000 plants per acre (such stands are used in an effort to hasten opening) to 26,000 plants per acre produced the greatest delay in leaf senescence and produced better quality fiber. The only increase in yield with 100 and 200 kg of N per hectare resulted in the thinned plots.

Bolls, squares, and leaves of different ages were sampled from 0 and 200 kg N/ha plots during the summer of 1975. Differences were found between ages and N treatments. This work was carried out with the Cotton Physiology Lab at Stoneville, Mississippi, and a full report dealing with the significance of the differences found is forthcoming. These results will add to knowledge of how and why metabolic pools vary in cotton.

Cotton plants were grown from seedling to the open boll stage at 3 different root temperatures. Leaf diffusion resistances, water and osmotic potentials, expansion rates, photosynthetic rates, and boll growth rates were determined.

Low root temperatures reduced leaf expansion on seedlings, but root temperatures did not affect any of the other responses measured.

Gainesville, FL (Plant Science Research Unit, Department of Agronomy): The digitgrass cultivars Pangola and Transvala differed in response to varied rhizosphere oxygen levels. Mineral uptake and growth rates of Pangola were not depressed appreciably by greater than 20 days exposure to solutions having oxygen concentrations of 100-125 µl/l. This restricted oxygen supply produced acute distress in Transvala plants. The adverse effects of sustained low rhizosphere oxygen conditions were exacerbated by inadequate

nutrient supply. Pangola was superior to Transvala in capability to survive under regimes which combined several stress influences.

Repeated inoculations of the rhizosphere with the nitrogen fixing bacterium Spirillum lipoferum, under low nitrogen but otherwise adequate nutrient conditions, increased dry matter production of both cultivars in some tests. However, tests with various inoculation methods and growth regimes have revealed none which insures a consistent favorable response to bacterial treatments.

Examination of rhizosphere bacterial populations by standard methods, following inoculation with a Spirillum lipoferum strain from Brazil, indicates that under the experimental conditions used this organism is not always a strong competitor for the available nutrient supply. Under axenic conditions it readily colonizes the mucigel layer of various grass species but in competition with other organisms often fails to do so. Some evidence from microscopic and fluorescent antibody studies suggests intra and inter cellular colonization in grass roots, but the evidence at hand indicates that rapid and sustained reproduction, when it occurs, is confined to the extracellular root environment.

The mucigel layer of grass roots provides an excellent environment for bacterial development, and the metabolites exuded by roots provide, at least in some circumstances, adequate substrate to support substantial bacterial activity. Under some circumstances we find this activity includes a significant rate of dinitrogen fixation, sufficient to sustain a moderate rate of plant growth. Studies are in progress to determine whether genetically or environmentally controlled conditions exist which impart specificity to the relationship between the host plant and the bacteria. Results in these investigations are not conclusive.

TO 6: Develop technology for control and regulation of biochemical, physical, and morphological process of plants.

Beltsville, MD (Light and Plant Growth Laboratory, PPhI): Dark-grown soybean cells have no photometrically detectable phytochrome; but when they are exposed to white light from a tungsten lamp, their photometrically detectable phytochrome content increases. By using wide bands of filters, a band of far-red light (690-720 nm) was found to be the effective spectral region for phytochrome increase. An action spectrum in the red and far-red regions for this light-induced phytochrome increase was determined using excised mung bean hooks. Two action maxima for phytochrome increase were found in the far-red. One was at 710 nm and the other was at 750-760 nm. Red light between 640-700 nm and far-red light between

780-800 nm failed to increase phytochrome content. In addition to a photochemical reaction, the phytochrome increase appears to require one or more dark processes which could be either chemical or physical. The results have been utilized to explain how plants respond to high irradiances.

Beltsville, MD (Plant Hormone and Regulators Laboratory): A search for new natural compounds that will aid in the understanding of normal plant growth and that can be used to beneficially control plant growth and behavior resulted in the discovery of several more plant species that possess biologically active components in sufficient quantities to cause growth responses in several test plant species. The active component from *Camptotheca* extracts was purified, identified as camptothecin, and shown to be a selective inhibitor of plant growth. Solutions (10^{-4} M) caused total inhibition of growth of axillary buds on topped Xanthi tobacco plants and marked retardation of growth of corn seedlings. Similar concentrations applied in lanolin to stems of tomato and sunflower plants caused a severe reduction of radial growth at the point of application and produced a gall above the treated area. Proliferation of axillary growth below the treated area and lack of axillary growth above plus the nature of the gall indicated a blockage of downward phloem transport. Anatomical studies of inhibited tobacco axillary buds indicate a selective inhibition of phloem development that would be sufficient to prevent growth.

Usefulness of the bean second internode test, for detecting very small quantities of biologically active compounds, was increased by defining the precise pretreatment growth room conditions in terms of light and temperature. Approximately 200 ft. candles of incandescent light for a 16 hour duration produced slightly etiolated seedlings that showed maximum response. Optimum temperatures were 90 deg. F for the first 2.5 days followed by 80 deg. F for the next 4 days.

"Split" internodes, a unique and characteristic response of bean stems treated with a highly purified complex from rape pollen extracts were studied from a tissue and cellular standpoint. Each segment was found to contain all of the various tissues of an intact stem; however, there was a reduction in the number of primary vascular cells. The reduction was proportional to the number of segments in the split area. A sequential study showed that the original stem swells, constricts at given areas, and divides into two, three, or four stem portions, each eventually containing a complete epidermis surrounding a full complement of tissue types.

Research was carried out to develop information to improve crop production by studying the biological activity of brassin with respect to plant growth, and by studying the role of certain chemicals on adventitious root formation. Leaf growth, flower opening, and pod set were accelerated and increased by application of the brassin complex to the second internode of bean plants. Early leaf area and plant weight were significantly increased by treating seed of soybean, barley, lettuce, cabbage, and mustard for one minute in a solution of brassins. Number and size of potato shoots were increased by treating the eyes of potato seed pieces with a brassin aqueous suspension before planting. New attempts to develop a bioassay for measuring brassin activity were made by treating barley at various stages during seed germination with a brassin suspension prior to growing them under a defined environment in a growth chamber.

Nitrogen fixation studies with soybeans indicate that the fixing capacity and specific activity of the plant is related to the degree of growth stimulus received by the plant from the brassin treatment.

Cytex, a commercial seaweed extract with claimed cytokinetic activity, showed as much root stimulation activity in the mung bean bioassay as indoleacetic acid. 3-Methylenexindole did not significantly influence root initiation in this bioassay.

Ithaca, NY (U.S. Plant, Soil and Nutrition Laboratory): A method for measuring the turnover of protein using ^3H glycine was developed and applied to legume seeds; the storage proteins were found to turn over very slowly (half-times of 39 days or greater) while the smaller proteins turned over more rapidly (half-times of 10-14 days).

Several aspects of the regulation of the synthesis of amino acids were studied: arginine was found to inhibit the transfer of the acetyl group from acetyl coenzyme A to glutamate, but not the transfer from acetylornithine. Cystathionine synthetase was found not to be regulated by methionine, S-adenosylmethionine or N^5 -methyltetrahydrofolic acid, while threonine synthetase was found to be activated by S-adenosylmethionine and inhibited by cysteine.

TO 7: Develop technology for reducing damage to crop plants from air pollution.

Beltsville, MD (Plant Stress Laboratory, PPhI): In potato experiments involving "open-top" chambers at Painter, Virginia, the average yield of four varieties in filtered air was 131 percent of the yield in nonfiltered chambers. With the variety, Superior, the yield in filtered air was significantly better than in nonfiltered air (172 percent). Yield increases from filtered air in 1975 were greater than in either of the previous two years.

Yields of early and later planted snapbeans were assessed in field chambers with carbon-filtered and nonfiltered air and in plots without chambers. For the early crop there was no significant difference in yields of four varieties in filtered and nonfiltered air. For the late crop, yields were higher in filtered air than in nonfiltered air, but the differences were not statistically significant. Two of the four varieties, Astro and Gallatin 50, produced significantly more beans in nonfiltered chamber plots than in plots without chambers. Air pollution stress was minimal and the bean production was reduced by heavy rains and very wet soil just prior to harvest of each crop.

The relative sensitivity to oxidants of 15 varieties and breeding lines of dry beans were assessed in Beltsville greenhouses. The commonly grown Michigan varieties, Seafarer, Sanilac, and Gratiot, were very sensitive to oxidants under the conditions of the test. In nonfiltered air they produced about 40 percent as much seed weight and total dry matter, 60 percent as many pods and 70 percent of the seed size as produced in filtered air. California Small White 59, a late maturing variety, was highly resistant.

PUBLICATIONS

Beltsville, MD

- Ambler, J. E., D. T. Krizek, and P. Semeniuk. 1975. Influence of UV-B radiation on early seedling growth and translocation of ^{65}Zn from cotyledons in cotton. *Physiol. Plant.* 34(3):177-181.
- Bennett, H. H. and A. C. Hill. 1976. Interactions of air pollutants with canopies of vegetation. *In* Responses of plants to air pollution. Academic Press, Inc., New York, NY, pp 273-306.
- Bennett, J. H. and A. C. Hill. 1975. Acute effects of combinations of sulfur dioxide and nitrogen dioxide on plants. *Environ. Pollut.* 9:127-132.
- Buta, J. G. and J. F. Worley. Camptothecin a selective plant growth regulator. *J. Agr. and Food Chem.* (In Press).
- Carns, H. R., D. T. Krizek, G. E. Carlson, J. Ambler, M. N. Christiansen, H. H. Klueter, and R. Hart. 1975. The freon/ozone problem - effect of UV-B radiation on the cotton plant. *Proc. Beltwide Cotton Production Research Conferences*, January 5-7, 1976. Las Vegas, NV, pp 55-57.
- Chatterton, N. J. 1976. The improvement of the efficiency of photosynthesis, particularly in order to better use solar energy. DAA/134(1976):1-7. A report presented at an experts meeting of the Organization for Economic Cooperation and Development, Paris, France, March 8, 1976.
- Davis, R. E., J. F. Worley and M. Moseley. 1975. Spiroplasmas: Primary isolation and cultivation in cystine-tryptone media and translational motility in semi-solid versions. *Proc. Amer. Phytopath. Soc. (Abs.)*.
- Dilley, D. R., H. E. Heggstad, W. L. Powers, C. T. Weiser. 1975. Environmental Stress. *In* Crop productivity-research imperatives. Michigan Agricultural Experiment Station, East Lansing and Charles F. Kettering Foundation, Yellow Springs, OH. pp 309-355.
- Graham, J. H., T. E. Devine, C. H. Hanson, and J. H. Elgin, Jr. 1975. Occurrence and variation of *Colletotrichum* spp. in Eastern United States. *Proc. First Eastern Forage Impr. Conf. Ontario.* pp 39-40.

- Graham, J. H., T. E. Devine, and C. H. Hanson. 1976. Occurrence and interaction of species of *Colletotrichum* on alfalfa in the mid-Atlantic United States. *Phytopathology* 66:538-541.
- Graham, J. H., T. E. Devine, J. E. McMurtrey, and D. L. Fleck. 1975. Agar plate method for selecting alfalfa for resistance to *Colletotrichum trifolii*. *Plant Dis. Rptr.* 59:382-384.
- Heggestad, H. E. 1976. Terrestrial effects of pollutants from energy use and progress in reclamation of coal strip mine areas. Health, environmental effects, and control technology of energy use. U.S. Environmental Protection Agency Report. 600/7-76-002, pp 168-171.
- Heggestad, H. E. 1975. Plant protection from oxidant air pollutants. In Reports and Informations, Section IV. Plant protection in relation to human health and environmental pollution. VII International Plant Protection Congress, Moscow, August, 1975.
- Heggestad, H. E. 1976. Air pollution injuries to stone fruit trees. In Virus diseases and non-infectious disorders of stone fruits in North America. *Agricultural Handbook* 437, ARS, U.S. Department of Agriculture, pp 355-364.
- Heggestad, H. E., W.L. Craig, L. P. Meiners, and A. W. Saettler. 1976. Response in Beltsville greenhouses of dry bean cultivars and breeding lines to oxidant air pollution. Abstract. In Proceedings American Phytopathological Society.
- Howell, R. K. 1975. Ozone and sulfur dioxide - their effect on nutrient composition of forages. Report on Conference on Rumen Function. Chicago, IL, p 5.
- Howell, R. K. 1975. Effects of air pollution on food production. Proceed. of 30th Annual Meeting of Soil Conservation Society of America, San Antonio, TX, p 61-67.
- Howell, R. K. 1976. Comparison of ozone and UV-C like injury to "Chico" peanut leaves in field plots. Proceedings of the American Phytopathological Society. Vol. 3, 1976.
- Krizek, D. T. 1975. Influence of ultraviolet radiation on germination and early seedling growth. *Physiol. Plant.* 34(3):182-186.

- Krizek, D. T. 1975. Biological Effects of Ozone Reduction. pp 53-64. In Fluorocarbons and the Environment. Chapter IV in Report of the Interagency Task Force on Inadvertent Modification of the Stratosphere. White House Council on Environmental Quality and Federal Council for Science and Technology.
- Krizek, D. T. 1975. Maximizing plant growth in controlled environments. Proc. XIX International Horticultural Congress, Warsaw, Poland, September 11-18, 1974. pp 145-153. Also published in Phytotronics III: Phytotronics in Agricultural and Horticultural Research. (P. Chouard and N. de Bilderling, eds., Gauthier-Villars, Paris). pp 6-13.
- Krizek, D. T., R. W. Langhans, T. W. Tibbitts, R. A. Larson, W. L. Berry, J. C. McFarlane, D. P. Ormrod, and P. A. Hammer. 1975. Standardization of controlled environment research. pp 222-229. In Phytotronics III, Phytotronics in Agricultural and Horticultural Research. (P. Chouard and N. de Bilderling, etc., Guathier-Villars, Paris).
- Krizek, D. T. 1975. Influence of UV-B radiation on germination and early seedling growth of selected vegetables and field crops. Presented at annual meeting, Amer. Soc. for Hort. Sci., Honolulu, Hawaii. Hort. Science 10(3):323. (Abstract No. 12).
- Krizek, D. T. and P. Semeniuk. 1975. Comparative sensitivity of bedding plants to UV-B radiation, presented at annual meeting, Amer. Soc. for Hort. Sci., Honolulu, Hawaii. Hort. Science 10(3):323. (Abstract No. 113).
- Krul, W. R. and G. C. Colclasure. 1976. Effect of galactose and other monosaccharides on IAA movement in bean hypocotyl segments. *Physiologia Plantarum*. (Being Revised).
- Krul, W. R. 1976. Demonstration of several auxin transport properties in an empirical diffusion model. *Physiologia Plantarum*. (Abstract). *Plant Physiol.* 57 (Suppl.) No. 5, p 3.
- Leffel, R. C., P. R. Henson, and L. A. Tayman. Nine cycles of selection for improved seedling vigor in "Empire" birdsfoot trefoil. (Abstract). Northeastern Branch American and Eastern Division Canadian Society of Agronomy, Joint Meeting, Ontario, Canada, July 14-16, 1975.
- Mandava, N. and L. E. Gregory. 1975. Effect of 3-methyleneoxindole on root initiation of mung bean hypocotyl. *Phyton* 33:173-177.

- Mandava, N. and J. F. Worley. 1976. New plant hormones - Progress on chemistry and physiology. Second Symposium on Plant Growth Regulators. Bulgarian Academy of Sciences. (Abstract).
- Meudt, W. J. and J. F. Worley. 1976. Histological development of floral and vegetative buds on Xanthi-nc tobacco plants treated with DPX-1840. *Plant Physiol.* 57:61. (Abstract).
- Murray, J. J., R. K. Howell, and A. C. Wilton. 1975. Differential response of seventeen *Poa protensis* cultivars to ozone and sulfur dioxide. *Plant Dis. Rptr.* 59:852-854.
- Orellana, R. G. and J. F. Worley. Cellular dysfunction in root nodules of soybeans grown in the presence of *Rhizoctonia solani*. *Physiol. Plant Pathology*. (In Press).
- Owens, L. 1975. Uptake of Col El plasmid DNA by plant cells. *Plant Physiol.* 56 (Suppl.) p 38. (Abstract).
- Sarvella, P., C. O. Grogan and D. L. Myhre. 1975. Comparison of morphology of leaves from normal, cytoplasmic male-sterile, and restored versions of Zea mays. *Can. J. Genet. Cytol.* 17:167-171.
- Sarvella, P. and C. O. Grogan. 1976. Stem morphology and anatomy in Zea mays L. as influenced by cytoplasmic male sterility and restorer genes. *J. of Plant Sci.* (In Press).
- Sarvella, P., G. W. Schaeffer, and H. Skoog. 1976. Plants obtained from cytoplasmic male-sterile Nicotiana pollen. In Vitro 12:331-332. (Abstract).
- Schaeffer, G. W. and H. A. Menser, Jr. 1975. Tissue culture of a tobacco albino mutant. *Crop Sci.* 15:728-730.
- Schaeffer, G. W. 1975. Tissue and anther culture of soybeans. *Plant Physiol.* 56 (Suppl.) p 27. (Abstract).
- Schaeffer, G. W., F. T. Sharpe, Jr., and A. J. Oakes. 1976. Potentials pitfalls in the anther culture and biochemical selection of unique cell types in rice and tobacco. *Proc. Rice Technical Working Group*, Lake Charles, LA. (In Press).
- Schaeffer, G. W. and K. Norris. 1976. Effect of indole-3-lactic acid upon soybean tissue cultures. *Plant Physiol.* 57 (Suppl.) p 66. (Abstract).

- Schaeffer, G. W. 1976. Tissue culture of a lethal albino mutant (SuSu) of tobacco. In Vitro 12:331. (Abstract).
- Schaeffer, G. W. 1976. Culture and morphogenetic response of a lethal, chlorophyll-deficient mutant of tobacco to hormones, amino acids and sucrose. In Vitro. (In manuscript, submitted to Technical Editors for review).
- Scharen, A. L., G. W. Schaeffer, L. M. Krupinsky, and T. F. Sharpe, Jr. 1975. Effects of flag leaf lesions caused by Septoris nodorum on ¹⁴C translocation and yield of wheat. Physiol. Plant Path. 6:193-198.
- Shibayama, H. and J. F. Worley. 1975. Growth responses of barnyardgrass and bearded sprangletop to benthocarb. Asian-Pacific Weed Sci. Soc. (Abstract).
- Shibayama, H. and J. F. Worley. 1976. Growth responses of barnyardgrass and bearded sprangletop to benthocarb. Weed Science 24:276-281.
- Sloger, C. Associative nitrogen fixation in corn. Plant Physiol. 57:102. 1976.
- Snyder, F. W. 1974. Maturity effects on fruit characteristics, germination, and emergence of sugarbeet. J. Amer. Soc. Sugar Beet Technol. 18:87-95.
- Snyder, F. W. 1975. Leaf and root accretion by sugarbeet seedlings in relation to yield. J. Amer. Soc. Sugar Beet Technol. 18:204-213.
- Snyder, F. W. 1975. Research for improving sugarbeet seed quality. Amer. Soc. Sugar Beet Technol. Proc. 18th Eastern Reg. Mtg., Eastern U.S. pp 12-15.
- Tibbitts, T. W., J. C. McFarlane, D. T. Krizek, W. L. Berry, P.A. Hammer, R. W. Langhans, R. A. Larson, and D. P. Ormrod. 1976. Radiation environment of growth chambers. Jour. Amer. Soc. Hort. Sci. 101(2):164-170.
- Toole, V. K., N. Mandava, and J. F. Worley. Seed germination and dormancy responses to acetone condensation products. J. Plant and Cell Physiol. (In Press).

Worley, J. F. and N. Mandava. 1976. Brassins. Encyclopedia of Science and Technology. McGraw-Hill. (In Press).

Zielke, R. C. and F. W. Snyder. 1974. Impurities in sugarbeet crown and root. J. Amer. Soc Sugar Beet Technol. 18:60-75.

Ithaca, NY

Everett, G. A. and J. T. Madison. 1976. Nucleotide sequence of phenylalanine transfer ribonucleic acid from pea (Pisum sativum, Alaska). Biochemistry 15:1016-1021.

Morris, C. J. and J. F. Thompson. 1975. Acetyl coenzyme A-glutamate acetyltransferase and N²-acetylornithine-glutamate acetyltransferase of Chlorella. Plant Physiol. 55:960-967.

Mississippi State, MS

Alberte, R. S., J. D. Hesketh and J. S. Kirby. 1975. Comparisons of photosynthetic activity and lamellar characteristics of virescent and normal green peanut leaves. Z Pflanzen Physiologie 77:152-159.

Alberte, R. S., J. D. Hesketh, G. P. Thornber, and A. Kleinhofs. 1976. Comparisons of photosynthetic activity and chloroplast lamellar characteristics of chlorophyll mutants of barley. Plant Physiol. (Suppl.).

Guinn, G., K. E. Fry, J. R. Mauney, J. W. Radin, and J. D. Hesketh. Evidence that photosynthesis limits yield of cotton. Proc. Beltwide Cott. Prod. Res. Confs. Las Vegas, NV. January, 1976.

Hesketh, J. D. and J. W. Jones. 1976. Some comments on computer simulators for plant growth--1975. Ecological Modeling (Denmark). (In Press).

Hesketh, J. D., H. C. Lane, and A. C. Thompson. Partitioning photosynthate in a field N trial, with emphasis on internodal wood and bark growth. Proc. Beltwide Cott. Prod. Res. Confs. Las Vegas, NV. January 1976.

McMichael, B. L., J. D. Hesketh, and C. D. Elmore. 1975. Root temperature effects on cotton plant growth, photosynthesis, and water status. Agron. Abstracts, p 74.

Thompson, A. C., H. C. Lane, J. W. Jones and J. D. Hesketh. 1976.
Nitrogen concentrations of cotton leaves, buds, and bolls in
relation to age and nitrogen fertilization. Agron. Jour. (In Press).

Peoria, IL

Khanna, P., R. Sharma, and R. Khanna. 1975. Pyrethrins from in vivo
and in vitro tissue culture of Tagetes erecta Linn. Ind. J. Exp.
Biol. 13:508-509.

Newton, J. W. 1976. Photoproduction of molecular hydrogen by a plant-
algal symbiotic system. Science 191:559-561.

Newton, J. W. 1976. Photoproduction of molecular hydrogen by a plant-
algal symbiotic system. Presented at Brookhaven National Laboratory,
Upton, Long Island, NY, April 8, 1976.

NRP Annual Report
FY 1976

NRP 20180 Crop Pollination, Bees and Honey

NPS Contact: E. C. Martin

PACS Contact: M. T. Ouye

Technological Objectives:

1. Improve management of honey bees for most effective crop pollination and honey production.

Pollen is essential for honey bee colony development. Changing land use patterns limit its general availability for optimum colony productivity. Tests have indicated several nutritional requirements of bees and some satisfactory pollen substitutes have been developed. Feeding of substitutes may be helpful in most areas during several periods of the year. Some of the volatile chemicals in pollen attractive to bees have been identified. WR, Tucson, AZ; NER, Beltsville, MD; NCR, Madison, WI.

Each year many thousands of packages of bees are shipped from Southern States to northern beekeepers. Tests have indicated that a cumbersome syrup feeder can be replaced by a lighter sugar fondant. NER, Madison, WI.

2. Improve methods of protecting bees from pesticides, diseases, pests, and pollution.

Progress has been made towards development of a method of controlling wax moth by irradiation induced decreased fitness. SR, Baton Rouge, LA.

Combined ETO fumigation of equipment and oxytetracycline treatment of colonies gave efficient control of American and European foulbrood. Registration of ETO is expected in the near future. NER, Beltsville, MD.

Chalkbrood (Ascosphaera apis) was found to be capable of transmission by queens and in fed pollen. This indicates the possibility that it was introduced to this continent in pollen purchased from European beekeepers. NER, Beltsville, MD; WR, Laramie, WY.

Partial relief from serious pesticide damage in Arizona cotton fields was obtained by providing water within the hive, bottom ventilation, wet burlap on the entrance, shade, pollen and syrup feeding. Although too complicated for commercial use at this stage, it is pointing towards relief from the devastation caused to bee colonies in many areas. WR, Tucson, AZ; Laramie, WY.

Normal life expectancy tables are being worked out for honey bees. Studies of the effect of selected pesticides on adult and larval honey bees continues. WR, Tucson, AZ.

3. Determine pollination requirements of economically important crops.

Soybean yields were increased up to 20% in plots caged with bees. At least two colonies of bees per acre were needed for maximum cranberry yields. NCR, Madison, WI. Differences in floral characteristics, including aroma, between male-sterile and fertile lines of carrot and onion were found. Bees fidelity to specific floral characteristics appears to limit effective cross pollination for the production of hybrid seed. NCR, Madison, WI; WR, Tucson, AZ.

Several commonly used agricultural chemicals were found to reduce pollen tube growth in onion, cherry, apple and wild plum. NER, Madison, WI. Pima S₄ cotton flowers exposed to cross pollination by bees set 50% more bolls than bee-excluded flowers. Cross-pollinated flowers produced 40% more seed per boll. WR, Tucson, AZ.

4. Identify and study biology of wild bee pollinators and improve methods of using wild bees for crop pollination.

A combination of three types of traps has made a great contribution to controlling the wasp Sapyga pumila, parasitic on alfalfa leaf-cutter bees. Rate of wasp parasitism has been reduced from 74% prior to controls to a present 3% where controls are practiced. Management techniques for the use of Osmia lignaria in pollinating commercial orchards have been worked out.

Cooperative studies of biology and management of potential alfalfa pollinators are being carried out in India, Pakistan, Egypt, Poland and Spain. Some bees being studied are candidates for use in the U.S. Native pollinators of cotton, onions, carrots, squash, almond and other crops are being identified and assessed for commercial use. Basic research on the systematics and biology of wild bees continues. WR, Logan, UT.

5. Improve honey bee breeding and rearing.

A major thrust in bee breeding is in the development of a selection index. This involves development of lab techniques to assess characteristics, and estimate heritability and combinability of stocks or inbred lines. Improving the choice and quality of bee stocks for commercial use in diverse environments has many complications. The selection index will hopefully quantify characteristics so predictable selections can be made. Efforts are underway to incorporate longevity, nosema resistance, hoarding instinct, and aggressiveness into the selection index. Incorporation of other characteristics will follow.

Progeny were produced from honey bee semen stored in liquid N₂. If the sperm remains viable for several years, the method will provide unlimited storage potential of genetic material. The stock center provided 187 queens of 34 types to 37 recipients.

Monitoring the movement and behavior of Africanized bees in South America continues. These bees are now well established in Guyana and have entered southeastern Venezuela. Suggestions on the development of a bee breeding station on Margarita Island and development of an expanded research, survey and extension capability in apiculture have been made to Venezuela. SR, Baton Rouge, LA.

6. Develop methods of detecting honey adulteration (taken from NRP 20520).

A new specific enzymic method for sucrose determination in honey has been developed and is in interlab. testing process. Methods to detect high fructose corn syrup are concentrating on the differences in complex sugars. Guidance provided to FDA district laboratories and custom laboratories has resulted in seizure of three lots of adulterated, imported honey and refusal of entry of nearly 2,000,000 lbs. The Honey Industry Council funded an analytical chemist who has analyzed several hundred samples for proline. NCR, Philadelphia, PA.

Selected Publications Pertinent to Annual Report

NRP #20180 - Crop Pollination, Bees & Honey

- Detroy, B. F. 1976. Electrically heated capping separator. *Apiacta* 11:14-19.
- Erickson, E. H. 1975. Honey bees and soybeans. *Am. Bee J.* 115:351-353.
- Erickson, E. H. 1975. Variability of floral characteristics influences honey bee visitation to soybean blossoms. *Crop Science* 15:767-771.
- Erickson, E. H. 1975. Surface electrical potentials on worker honey bees leaving and entering the hive. *J. Apicult. Res.* 14:141-147.
- Erickson, E. H., Miller, H. H., Sikkema, D. J. 1975. A method of separating and monitoring honey bee flight activity at the hive entrance. *J. Apicult. Res.* 14:119-125.
- Erickson, E. H., Thorp, R. W., Briggs, D. L. 1975. Comparison of foraging patterns among honey bees in disposable pollination units and in overwintered colonies. *Environ. Entomol.* 4:527-530.
- Gilliam, M. A. 1975. The absence of yeasts in nectars of selected Arizona plants attractive to honey bees. *Annals Entomol. Soc.* 68:705-706.
- Gilliam, M. A., Argauer, R. J. 1975. Stability of oxytetracycline in diets fed to honey bee colonies. *J. Invertebr. Pathol.* 26:383-386.
- Harbo, J. R. 1975. Measuring the concentration of spermatazoa from honey bees with spectrophotometry. *Annals Entomol. Soc. Am.* 68:1050-52.
- Loper, G. M. 1976. Differences in alfalfa flower volatiles among parent and F_1 plants. *Crop Science* 16:107-110.
- McGregor. 1976. Insect Pollination of Cultivated Crop Plants. Washington, U.S. Gov't. Print. Off. 411 pp.
- Mehr, Z., Menapace, D. M., Wilson, W. T., Sackett, R. 1976. Studies on the initiation and spread of chalkbrood within an Apiary. *Am. Bee J.* 116:266-268.
- Moeller, F. E. 1975. Effects of moving honey bee colonies on their subsequent production and consumption of honey. *J. Apicult. Res.* 14:127-130.
- Moffett, J. O., Lawson, F. A. 1975. Effect of Nosema infection on O_2 consumption by honey bees. *J. Econ. Entomol.* 68:627-629.
- Moffett, J. O., Morton, H. L. 1975. How herbicides affect honey bees. *Am. Bee J.* 115:178-179, 200.

- Moffett, J. O., Morton, H. L. 1975. Repellency of surfactants to honey bees. *Environ. Entomol.* 4:780-782.
- Moffett, J. O., Rodney, D. R. 1975. Effect of honey bee visits on yields of caged lemon trees. *Am. Bee J.* 115:310-311, 313.
- Moffett, J. O., Stith, L. S., Burkhardt, C. C., Shipman, C. W. 1975. Honey bee visits to cotton flowers. *Environ. Entomol.* 4:203-206.
-
1975.
The influence of different cotton genotypes on the floral visits of honey bees. *Crop Science* 15:782-785.
-
1975.
Nectar secretion in cotton flowers and its relation to floral visits by honey bees. *Am. Bee J.* 116:32,34, 36.
- Morton, H. L., Moffett, J. O., Stewart, F. D. 1975. Effect of alfalfa looper nuclear polyhedrosis virus on honey bees. *J. Invertebr. Pathol.* 26:139-140.
- Parker, F. D. 1975. Nest descriptions and associates of three American bees of the genus Authocopa Pan-Pacific. *Entomol.* 51:113-122.
- Spangler, H. G. 1975. Vibration regulated honey bee flight for pollination in polythlene greenhouses. *Am. Bee J.* 115:392-393.
- Taber, S., Barker, R. J., Lehner, Y. 1975. Sugars collected by honey bees from honeydew of the scale, Tonnemeyella mirabilis on mesquite. *Environ. Entomol.* 4:339-340.
- Taber, S., Sackett, R., Mills, J. 1975. A possible control for chalkbrood disease. *Am. Bee J.* 115:20.
- Thorp, R. W., Briggs, D. L., Estes, J. R., Erickson, E. H. 1975. Nectar fluorescence under ultraviolet irradiation. *Science* 189:476-478.
- Torchio, P. F. 1975. The biology of Perdita nuda. *J. Kans. Entomol. Soc.* 48:257-279.
- Tritt, S. E., Wilson, W. T. 1975. The effects of Penicillium waksmani growth on American foulbrood infected combs and adult honey bee activity. *J. Invertebr. Pathol.* 26:283-87.
- White, J. W., Jr. 1975. Honey. Chapt. 17 in The Hive and the Honey Bee, Dadant & Sons. 740 pp.
-
1975. Composition of honey. Chapt. 5; Physical characteristics of honey. Chapt. 6, in Honey: A Comprehensive Survey. Ed. Eva Crane, New York: Crane, Russak & Co. 608 pp.
- Woyke, J. 1975. DNA content of spermatids and spermatazoa in haploid and diploid drone honey bees. *J. Apicult. Res.* 14:3-8.

NRP Annual Report
FY 1976

NRP 20190, IMPROVED METHODS AND EQUIPMENT FOR PRODUCTION OF
FIELD, FIBER, AND HORTICULTURAL CROPS

TECHNOLOGICAL OBJECTIVES

- 1 To develop improved equipment for harvesting crops to reduce field losses, improve product quality, reduce labor and machinery costs, and reduce fossil fuel use.
- 2 To develop improved equipment and techniques for farm handling, cleaning, drying and processing of harvested crops to improve quality, reduce costs of labor and machinery, and reduce fossil fuel use.
- 3 To develop improved equipment and techniques for tilling, planting, transplanting, fertilizing, and cultivating to increase production, reduce labor and machinery costs, reduce fossil fuel use, and improve harvesting efficiency.
- 4 To develop equipment and facilities to control environmental factors that affect crop production in greenhouses, in plant growth rooms and in the field.

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RESEARCH LOCATIONS

1109	Beltsville, Maryland	7313	Lubbock, Texas
3311	Urbana, Illinois	7402	Stoneville, Mississippi
3508	East Lansing, Michigan	7502	Mississippi State, MS
5203	Shafter, California	7506	Auburn, Alabama
5205	Salinas, California	7609	Lake Alfred, Florida
5210	Riverside, California	7614	Belle Glade, Florida
5220	Honolulu, Hawaii	7702	Tifton, Georgia
5803	Wenatchee, Washington	7706	Byron, Georgia
5809	Corvallis, Oregon	7809	Lexington, Kentucky
7307	Temple, Texas	7812	Suffolk, Virginia

National Research Program Annual Report 20190

IMPROVED METHODS AND EQUIPMENT FOR PRODUCTION OF FIELD,
FIBER, AND HORTICULTURAL CROPS

Technological Objective III.1: Develop improved equipment for harvesting crops to reduce field losses, improve product quality, reduce labor and machinery costs, and reduce fossil fuel use.

The reported results indicate progress in the development of harvesting equipment to reduce field losses for soybeans, onions, papaya, seeds, cotton, citrus, sugarcane and peanuts.

Improvements in harvesting equipment to reduce quality losses were reported for forage, pecans, sugarcane, seeds, cotton, lettuce and papaya. Removal of trash and clearing during harvesting accounted for most of the quality improvement.

Reports on mechanical harvesting for all crops show reductions in labor inputs and costs. Machine cost reduction reports were limited to pecans, peaches, tobacco, cotton and citrus.

Reduction in fossil fuel use were not reported by any of the researchers working on harvesting. Some fuel savings are implied for tobacco, pecans, cotton and citrus.

Following are some examples of recent progress:

Urbana, Illinois: Further testing of the air-jet header proves that it consistently reduces soybean harvesting losses to less than 3 percent of yield. Interest in this design has been shown by several combine manufacturers. Laboratory studies indicate that modifications to the standard guard used on conventional cutterbars may reduce harvesting losses by 50 percent. Preliminary studies show no significant damage to soybean seed from conventional planter or drill meters if seed moisture is 12 percent or greater. In 1974 and 1975 Corsoy soybeans provided a 12 to 23 percent yield increase in 18 cm. rows when compared with both Corsoy and Williams in 76 cm. rows. When pulled behind a tillage tool to remove the tractor tire tracks and provide a uniform seedbed, both the end-wheel drill and the press-wheel drill were satisfactory for planting soybeans and obtaining target stands. When used with a press-wheel drill, a planter harrow was as effective for seedbed preparation as a packer mulcher.

East Lansing, Michigan: Data was obtained for the third year on late winter shake pruning of pear trees in orchards in Southwest and Northwest Michigan. Results showed about 12 pounds of dead and other wood per tree were removed at rates of a tree every 40 seconds. During mechanical harvest of the same trees 5 percent less trash was obtained, removal of the pears was increased by 20 percent because of a stiffer tree and less damage occurred to the pears because they hit fewer limbs.

An over-the-row power frame was designed and constructed for use in high-density plantings of orchards. It requires less space between rows and can increase land use by 20 percent.

A cluster breaker was designed, constructed and tested to singulate grapes from partial or whole clusters in mechanically harvested grapes. Brush speeds, stiffness and clearance were varied and at proper settings -- 95 to 100 percent effectiveness was achieved in singulating grapes from clusters.

A pickup unit consisting of a potato digger chain was constructed to interchange with the conventional hay-type pickup and rubber belt of a Wilde cucumber harvester and tested. In sandy loam soils recovery was better and dirt pickup was less than the conventional pickup. The unit was tried successfully in harvesting butternut squash and has possible use in harvesting tomatoes and peppers.

Salinas, California: Modifications were made on the lettuce harvester to accommodate bulk handling from the harvester to a centralized field inspection and packing unit and/or accommodate a jumble pack system to increase harvesting efficiency. Simulated studies on the transit vibrations for jumble filled bins and conventional cartons showed that the loss of saleable lettuce was 10 percent less with the jumble filled bins.

The cauliflower harvester was tested extensively in tied and untied fields of snowball cauliflower. The selector rollers were increased in diameter from 5 inches to 13 inches which greatly improved the accuracy of the cauliflower harvester in untied fields and made it operate more smoothly in the tied fields. Damage to the plants that remained in the field appeared to be less with the 13-inch diameter rollers than with the 5-inch diameter rollers. The machine accuracy was almost as good as the accuracy of a hand crew. The damage to the harvested cauliflower heads was evaluated several times and found to be very slight.

Riverside, California: The cooperative project with University of California, to study lemon wood strength characteristics, was completed. Certain rootstocks did have a significant effect on the strength of lemon scions but did not significantly affect the damping properties of the scions. A report summarizing this research was completed and submitted to reviewers. Methods and results from this study can be used by other scientists in evaluating current citrus rootstock-scion combinations and for selecting new rootstock-scion combinations.

The components for an onion harvesting system including a topper, undercutter, and retrimmer were field tested during the year. The field topping unit removes in excess of 60 percent of the tops while the retrimmer removes 80 percent of the tops and roots. Therefore, once through, the system properly trims a total of 92 percent of the bulbs. Bulb injury appears to be no problem. When these components are incorporated in a harvesting system, the unit will have a capacity of 12-16 acres per day, reduce labor by 75 percent, and reduce harvesting costs by 40 percent.

Honolulu, Hawaii: An improved prototype of a papaya harvester was designed and fabricated. It and the original prototype were evaluated for performance in the field. The amount of immature and damaged fruit harvested was significantly lower than in hand harvesting. The orchard life was significantly increased as taller trees can be harvested with the machine than can be harvested by hand.

Wenatchee, Washington: The low profile, self-propelled catching frames were evaluated for improved apple and pear harvesting. The fruit flow path developed for this experimental harvester maintains the apple quality by minimizing the fruit-on-fruit bruising which occurs at the fruit transfer points of commercial harvesters. Limited apple harvesting field tests yielded harvest rates of less than 2 minutes per tree and less than 10 percent culls due to harvest damage for Red Delicious.

Feasibility trials for Bartlett pear harvesting indicated the need for an increased shaking force and a revised fruit handling system to facilitate the movement of the oblong pear at conveyor transfer points. Pear removal, with a large trunk shaker, was about 92 percent with 32.5 percent broken stems and 4 percent spurs.

The harvesting components were removed from the straddle-frame unit and the hydraulic circuit was redesigned to power four pruning attachments. The attachments will allow a single-pass mechanical hedging and topping operation for high density tree walls to reduce pruning labor.

Corvallis, Oregon: Field tests were made with the experimental combine to evaluate the pneumatic system modifications as well as a new supplemental Chaffer and alterations in the straw walker and material conveying systems. The machine operation in fields of crimson clover, alta fescue, ryegrass, and wheat demonstrated that these seed crops were satisfactorily threshed and cleaned, but seed losses were excessive. Sources of loss were determined for later corrections. The new chaffer was very effective in removing additional components and contributing toward sustained operations.

Lubbock, Texas: When cotton was stripper harvested, stick length increased with plant size and with a delay in harvest. Handling by the harvester and precleaning machinery in the gin shortened stick length. The number of bark slivers attached to each stick increased as length decreased. Sticks that contribute bark tend to be long representing 30 percent of the total by number and 50 percent by weight.

A pneumatic suction system over the brush harvester rolls removed up to 63 lbs. per acre of fine material but did not significantly decrease the amount of fine trash in the harvested cotton. The operating height of harvester head had a significant effect on the amount of fine material collected in the cotton.

Stoneville, Mississippi: In meeting the requirement for a more economical method of harvesting small cotton on clay soils in the Mississippi Delta, two types of once-over stripper harvesters were evaluated with respect to efficiency, product quality and net returns. The highest boll removal efficiencies and highest net returns on heavy clay were obtained with a brush-roll stripper. It is evident that early plant maturity and boll opening will be required for the successful use of a once-over stripper in this area.

Large lots of both chemically defoliated and non-defoliated cotton were harvested with a tapered-spindle picker. Defoliation reduced dust levels, both in the gin and mill.

A completely new principle of harvesting with air powered boll-removal equipment was investigated. Initial results indicated extremely high air pressures would be required for this type of machine to be successful.

Mississippi State, Mississippi: Total harvested cotton yield from the 40" rows using a spindle type picker was significantly higher than from the narrow rows using a stripper harvester this year. However, when all harvesting losses were considered, there was no significant difference in yield between the varieties and/or row widths. Planting the standard (slow maturing) variety in narrow rows did not hasten maturity this year as it had in previous years. Although the faster maturing varieties in narrow rows had 60 percent open bolls from 4 to 15 days earlier than the standard variety, more cotton was picked from the first picking from the 40" rows than from the once-over stripping of the narrow rows of any of the varieties. In this 5-year study, 15" rows have yielded more than 40" rows in 3 years, but only one year's yield was significantly different. The 40" rows, machine picked, had significantly higher yields the other 2 years.

A daily simulation computer program was developed which delivers the colorimeter quality of the cotton in the field and converts this quality to standard classer's grade. A market value of the cotton is then calculated daily in the program using premiums and discounts based on the classer's grade. The daily simulation program allows for harvests to occur at various times during the season to provide a method for harvest schedule optimization.

Ten days of high humidity did not seriously affect the quality of fully opened bolls at temperatures of 20, 25, 30 and 35°C. The quality of the freshly opened (cracked) bolls did decrease sharply under these conditions. The rate of decrease was approximately constant for each of the 4 temperatures but the time delay before the decrease started was shortened with higher temperatures.

Auburn, Alabama: Field tests were completed for the experimental seed cotton cleaner for stripped seed cotton. Bale lot samples of cotton were collected for spinning performance analysis and samples were collected for a ginning comparison of the cleaned stripper cotton and spindle

picker cotton. When used in conjunction with the proper production system, such as narrow row spacing, the cotton stripper can be depended upon to harvest a higher percentage of crop from the field, reduce machinery cost (both initial and maintenance), reduce labor through the use of a once-over harvest system, and maintain essentially the same quality.

Lake Alfred, Florida: Harvest rate and removal efficiency of the rotating weight shaker were evaluated in citrus trees sprayed with an abscission chemical. Fruit removal efficiency and harvest rate were increased by the use of an abscission chemical and fewer limbs per tree were shaken. Fruit yield reduction was 25 to 50 percent in Valencia orange trees shaken with three limb shakers. The least yield reduction occurred in chemical sprayed trees shaken with a reduced shaking action. Modifications made on the USDA shaker during the harvest season included: (1) Replacing the limb clamp pads with a commercial unit, (2) Adding a protective cover over the operator, and (3) making a suspension arm adaptor for mounting a commercial crank-drive shaker.

A tractor mounted raking system with three oblique rakes for windrowing citrus to be picked up at the tree drip line was field tested in several orange groves. A brush rake with 3 rotary brushes was compared with the oblique rakes for raking capacity and resultant fruit quality. Rake speeds of 0.75 to 1.25 mph were obtained with both rakes. The brush rake was not as efficient in high fruit yields and uneven soil conditions as the oblique rake, however, the brush rake caused less fruit damage.

The offset pickup machine was field tested in several orange groves throughout the season. Modifications were made on the pickup assembly to increase the pickup width to 50 inches and a heavier rod draper chair was installed to better handle the sticks. The ground speed on the pickup machine varied from 1/2 to 3/4 mph with a maximum pickup rate of 10 boxes per minute.

The trash eliminator assembly was lengthened by 8 inches and the inclined angle was set at 22°. These modifications increased the capacity of the pickup machine.

Belle Glade, Florida: The mechanized harvesting efficiency was greatest with sugarcane varieties that are erect and can produce well at high population levels. In-row plant cane skips of 2.0 meters or more caused reductions in cane yields and harvesting efficiency.

Performance tests were made on several fan blades in a 36-inch diameter vertical duct. A new regressive pitch fan blade continued to give good cleaning results with 7 percent less horsepower usage. Several types of perforated discs were designed to operate below the suction fans to remove trash and sugarcane that enters the fan blades. Discs with 57 to 80 percent open area perform satisfactorily and may solve maintenance and operational problems.

Sugarcane stalks were sent to commercial companies for cutting with laser, plasma arc and high speed fluid jet systems. These methods of cutting, which do not require contact with the plants, might be advantageous in cutting sugarcane without preharvest burning. Only the high speed fluid jet seems practical and it has a high energy usage and high water consumption for a field machine.

Tifton, Georgia: Pelleted Coastal bermudagrass, pelleted 44 bermudagrass and baled 44 bermudagrass were fed to dairy heifers in a 56-day feeding trial. The heifers which had an average initial weight of about 263 kg made average daily gains as follows: Coastal bermudagrass pellets 0.80 kg, 44 bermudagrass pellets 0.89 kg, baled 44 bermudagrass 0.54 kg. The feed consumed per kg of gain was 7.50 kg, 6.97 kg, and 9.07 kg for the Coastal bermudagrass pellets, the 44 bermudagrass pellets and the 44 bermudagrass hay. Using the 44 bermudagrass for comparison purposes, pelleting increased average daily gain by 65 percent and reduced the feed required per unit of gain by 23 percent.

With a hybrid bermudagrass, the use of the tandem roll crusher resulted in the hay being dry enough to bale by 3:00pm the day after cutting. The hay crushed with the conventional crusher was not dry enough to bale until the next afternoon. In vitro digestibility studies showed no significant difference between the two machines in the digestibility of the grass.

In repeated tests with Coastal bermudagrass, bahia grass, millet and peanut hay, with moisture contents ranging from 10 to 50 percent, it was impossible to make a satisfactory wafer with a commercial wafering machine (Agropak). Even with binding agents ranging from parofin to molasses and several machine modifications, it was still impossible to successfully form a wafer.

A study was conducted to determine the relationship between maturity of peanuts at harvest and the grade, yield and dollar return per acre. Hand picked samples of peanut pods were collected at weekly intervals, along with mechanically harvested peanuts, for yield and grade determination. The samples were collected beginning with an age of 99 days and continuing through 148 days of age. A methanol extract of the hand-picked sample was made and the light transmittance of the extract was measured. As the maturity increased the light transmittance decreased. An analysis of the data showed a correlation coefficient of 0.95 for the maturity and light transmittance with the greatest dollar return per acre.

Byron, Georgia: Several critical components of the continuous-travel pecan harvester, including the shaker, between-trees seal and elevator, were rebuilt and extensively tested to insure reliability. An improved sealing device for the space close to the tree trunk, and a height-adjustable webbing-strips device for lowering fruits gently into bulk boxes were designed and constructed. The first in a series of off-station commercial peach orchard harvesting runs was conducted. Sixteen 18-bushel bulk boxes of fruit were machine harvested and followed through the packing shed.

In comparison to peaches had harvested in the same orchard, there was about a 14-percent reduction in value of packed fruit, the reduced value was almost entirely due to slight mechanical fruit-surface damage which occurred during the process of removal and falling through the trees. Further indications based on this initial commercial run are that a sustained harvest rate of 200 trees per hour can be maintained, and that one machine can handle about 300 acres during a harvest season. About 250 trees in one commercial orchard were sprayed with ALAR to promote uniform ripening of that variety for a mechanical harvesting run.

The small, low-cost, garden tractor-mounted pecan harvester was further field tested, modified to improve trash removal, evaluated and found capable of harvesting up to 400 lbs. of nuts per hour and handling orchards up to about 20 acres in size. Harvesting is still best under dry conditions.

Seedling Chinese chestnut trees were stripped of nuts in a simulated once-over harvest and then dried and stored following conventional practice. Evaluation of samples after 3 months' storage indicated quality and yield as good as nuts that were harvested from the ground 3 times a week after they fell naturally over a period of about a month.

Lexington, Kentucky: A one-man, self-propelled, self-steered harvester was constructed and tested. The harvester was modified to correct unsatisfactory performance of the plant cut-off and self-steering assemblies. The harvester automatically cuts the plants and conveys them on an inclined open conveyor to the operator who manually spears the plants onto a mechanical spearing aid. An automatic device lifts the filled stick from the spear, allowing the operator to conveniently transfer the filled stick to the field for conventional wilting. Nominal ground speed is 30 to 35 fpm, equivalent to a harvesting capacity of one acre per six hours actual operation. Material cost of the harvester based on volume purchase is about \$500. The harvester parts can be fabricated and assembled with tools available in local machine shops.

Suffolk, Virginia: Application was made for a current patent of the peanut digger-salvager to include the added cleaning components not shown on the previous patent application. Another application for a patent was prepared to cover the 1975 model USDA peanut recleaner designed to be used in the field to reclean windrow harvested peanuts after combining but before drying. Patent applications were mailed to New Orleans several months ago.

PUBLICATIONS

Urbana, Illinois:

Nave, W. R. and R. R. Yoerger. Use of Air-Jet Guards to Reduce Soybean Harvesting Losses. Transactions of ASAE, Vol. 18(4):626-629, 1975.

Nave, W. R. and D. L. Hoag. Relationship of Sickles and Guard Spacing and Sickles Frequency to Soybean Shatter Loss. Transactions of ASAE, Vol. 18(4):630-637, 1975.

East Lansing, Michigan:

Tennes, B. R., C. L. Burton and H. H. Levin. Update on Compact Continuous Over-the-Row Apple Harvester. International Dwarf Fruit Tree Association, Vol. 9, 1976. Department of Hort., M.S.U., East Lansing, Michigan 48824.

Tennes, B. R., J. H. Levin and B. F. Cargill. Tests on Pallet Tanks for the Cherry Industry. Transactions of the ASAE, Vol. 18(4):623-625, 1975, St. Joseph, Michigan 49085.

Tennes, B. R., C. L. Burton and J. H. Levin. Concepts for Mechanizing Over-the-Row Harvesting. Transactions of the ASAE, Vol. 19(1):35, 36 and 40, 1976, St. Joseph, Michigan 49085.

Levin, J. H. New Developments in Mechanical Harvesting and Handling of Fruit Crops. The 105th Annual Report, State Horticultural Society of Michigan, pp. 54 & 55, 302 Hort. Bldg., M.S.U., East Lansing, Michigan, February 1976.

Marshall, D. E., J. H. Levin, D. R. Heldman, B. F. Cargill, and L. R. Baker. Reduction of Dirt in Mechanically Harvested Cucumbers. Michigan State University Farm Science Research Report 277, pp. 12, May 1975.

Cargill, B. F., D. E. Marshall, J. H. Levin. Harvesting Cucumbers Mechanically. Michigan State University Extension Bulletin E-859, 1975.

Sarig, J. Deformation Analysis of Foam-Encapsulated Apples Under Impact Loading. Michigan State University, Ph.D. Thesis, March 1976.

Snobar, B. A., B. F. Cargill, J. H. Levin, D. E. Marshall. An Engineering Economic Analysis of Mechanical Harvesting and Handling Systems for Concord Grapes. Transactions of ASAE, Vol. 19(2):227-229, May 1976.

Honolulu, Hawaii:

Liang, T. and Myers, A. L. Monitoring Macadamia Nut Quality in an Orchard to Determine an Optimal Shaker-Harvesting Date. Transactions of the ASAE, Vol. 18:233-235, 1975.

Gillespie, B. A., Liang, T., and Myers, A. L. Multiple Spectral Analysis for Tree Shaker Parameter Optimization. Transactions of the ASAE, Vol. 18:227-230, 1975.

Lake Alfred, Florida:

- Sumner, H. R. and Hedden, S. L. Harvesting Oranges with a Full-Powered Positioning Limb Shaker. Proc. of Florida, State Hort. Soc., Vol. 88: 117-120, 1975.
- Churchill, D. B. and Sumner, H. R. Developments in Pickup Equipment for Oranges to Reduce Windrowing. Proc. of Florida, State Hort. Soc., Vol. 88:124-127, 1975.
- Sumner, H. R., Whitney, J. D. and Hedden, S. L. Foliage Shaker for Citrus Harvesting--Part I: Design and Kinematics of Shaker Drive System. Transactions of the ASAE, Vol. 18:66-69, 1975.
- Churchill, D. B., Sumner, H. R. and Hedden, S. L. Developments in Citrus Pickup Equipment. ARS-S-84, 1975.
- Whitney, J. D., Sumner, H. R. and Hedden, S. L. Foliage Shaker for Citrus Harvesting--Part II: Harvesting Trials. Transactions of the ASAE, Vol. 18:70-73, 1975.

Belle Glade, Florida:

- Eiland, B. R. and Clayton, J. E. Developments in Mechanical Planting in Florida. Proceedings, American Society of Sugarcane Technologists, Vol. 5 (NS), 1975.
- Zepp, G. A. and Clayton, J. E. A Comparison of Costs and Returns for Hand Cutting and Mechanically Harvesting Sugarcane in Florida, 1972-1973 Season. Economics Report No. 70, Univ. of Florida, IFAS, June 1975.
- Clayton, J. E. and Eiland, B. R. Sugarcane Harvester and Transport Developments in Texas, Louisiana and Florida. Proceedings, Hawaiian Sugar Technologists, Vol. 34, 1975.
- Clayton, J. E., Eiland, B. R., and Franks, G. N. Methods of Removing Trash from Sugarcane on Chopper Harvesters. Proceedings, Hawaiian Sugar Technologists, Vol. 34, 1975.
- Clayton, J. E., Eiland, B. R., Miller, J. D., Lyrene, P. M., and Samol, H. H. Characteristics of Sugarcane Varieties Affecting Harvester Performance Efficiency. Proceedings, American Society of Sugar Cane Technologists, Vol. 6 (NS), 1976.
- Miller, J. D. and Eiland, B. R. Effect of Delay in Covering and Seed-Piece Lengths on Germination of Spring-Planted Sugarcane. Proceedings, American Society of Sugarcane Technologists, Vol. 6 (NS), 1976.

Wenatchee, Washington:

Berlage, A. G. and R. D. Langmo. Trunk Shaker Harvesting of Apples Surrounded by Plastic Spheres. Transactions of the ASAE, Vol. 19(2):209-212, 218, 1976.

Berlage, A. G. Apple Quality and Mechanical Harvesting. Third National Processed Apple Conference. Special Report 19, Cornell University Agricultural Experiment Station, November 1975.

Lubbock, Texas:

Baker, Roy V., and D. F. Wanjura. Ginning of Narrow-Row Cotton. USDA, ARS Production Research Report No. 160, December 1975.

Colwick, R. F., D. F. Wanjura and E. B. Hudspeth. HARSIM: A Simulation of Cotton Harvesting and Ginning: USERS Manual. ARS-S-52, pp. 83-98, 1975.

Stoneville, Mississippi:

Luckett, Kirk E., Charles S. Shaw, Gary L. Barker, and Warren E. Garner. Seed Cotton Drier for a Mechanical Picker. ARS-S-76, November, 1975.

Barker, Gary L., Charles S. Shaw, Kirk E. Luckett, and Fred T. Cooke, Jr. Effects of Defoliation, Plant Maturity, and Ginning Setup on Cotton Quality and Value in the Midsouth. ARS-S-120, June, 1976.

Mississippi State, Mississippi:

Colwick, Rex F., Barker, Gary L. (1975). Short Season Cotton Harvesting Studies. Beltwide Cotton Production Research Conferences Proceedings, January 6-8, New Orleans, Louisiana, pp. 114-115.

Barker, G. L., Colwick, Rex F., McClendon, R. W., Jones, J. W. (1975). Field Deterioration of Cotton. Beltwide Cotton Production Research Conference Proceedings, January 6-8, New Orleans, Louisiana, pp. 115.

Barker, G. L., R. W. McClendon, J. W. Jones and R. F. Colwick (1976). Effects of Field Weathering on Cotton Fiber Quality. Beltwide Cotton Production Research Conference Proceedings, January 5-9, Las Vegas, Nevada, pp. 122-123.

Colwick, R. F., G. L. Barker, and W. E. Garner (1976). A System for Early-Season Once-Over Harvesting in Mississippi. Beltwide Cotton Production Research Conference Proceedings, January 5-9, Las Vegas, Nevada, pp. 123-124.

Halsey, L. A. and Eiland, B. R. A Comparison of Costs of Various Planting Systems for Sugarcane. Presentation and Abstract, American Society of Sugarcane Technologists, Vol. 6 (NS), 1976.

Tifton, Georgia:

Butler, J. L. and J. M. Troeger. Considerations for Solar Drying of Peanuts. Proceedings of American Peanut Research and Education Association, Inc., Vol. 7(1) p-76, 1975.

Butler, J. L. Using Solar Energy in Agriculture. Proceedings of Southern Regional Education Board Conference-Workshop on Energy in Agriculture, 1975.

Utley, P. R., R. E. Hellwig and W. C. McCormick. Finishing Beef Cattle for Slaughter on All-Forage Diets. J. Animal Science, Vol. 40 (1975), No. 6, pp 1034-1038.

Byron, Georgia:

Peterson, D. L. and G. E. Monroe: 1976. Continuously Moving Shake-Catch Harvester. ASAE Paper No. 76-1052.

Lexington, Kentucky:

Bunn, J. M. and W. H. Henson, Jr. A Voltage-Controlled Oscillator as an Integrator. Agricultural Engineering, Vol. 57(4): 87-88, April 1976.

Casada, J. H., J. N. Walker and L. R. Walton. Handling Losses of Cured Burley as Related to Temperature and Moisture Content. Tobacco Science Vol. 20(1976): 40-42.

Dejong, D. W., J. J. Lam, R. H. Lowe, E. E. Yoder, and T. C. Tso. Homogenized Leaf Curing, Part II: Bright Tobacco. Beitrage zur Tabakforschung Vol. 8(2):93-101, 1975.

Tso, T. C., R. H. Lowe, and D. W. DeJong. Homogenized Leaf Curing, Part I: Theoretical Basis and Some Preliminary Results. Beitrage zur Tobakforschung Vol. 8(1): 44-51, 1975.

Morrison, J. E., Jr., and E. E. Yoder. Uniformity of Tobacco Seedlings Grown in Containers. Transactions of the ASAE, Vol. 18(6): 1032-34, 1975.

Walton, L. R., J. H. Casada, and J. N. Walker. Elasticity of the Cured Burley Tobacco Midrib. Transactions of the ASAE, Vol. 19(3): 382-84, 1976.

Morrison, J. E., Jr. and C. F. Abrams. Furrow Opener and Apparatus for No-Tillage Transplanter and Planter. (Patent, Case #6105, filed 10/2/75.)

National Research Program Annual Report 20190

IMPROVED METHODS AND EQUIPMENT FOR PRODUCTION OF FIELD,
FIBER, AND HORTICULTURAL CROPS

Technological Objective III.2: Develop improved equipment and techniques for farm handling, cleaning, drying and processing of harvested crops to improve quality, reduce costs of labor and machinery, and reduce fossil fuel use.

Reports on the development of equipment and techniques to reduce crop damage and improve quality indicate some progress for soybeans, cherries, cucumbers, lettuce, dates, seeds, forage, peanuts and peaches. Reductions in labor and machinery costs were reported for apples, lettuce, seeds, forage, and tobacco. Comparisons of fossil fuel use for handling peanuts and forage crops indicate that reductions can be made with the development of improved equipment and techniques.

Following are some examples of recent progress:

Urbana, Illinois: Some progress has been made in evaluating present grading and germination tests for soybeans. The tetrazolium test and an accelerated aging cold test appear to be the most reliable tests presently available for determining soybean seed quality. Other techniques are being investigated to establish methods for evaluating the effect of handling on soybean quality.

East Lansing, Michigan: Pitter efficiency which is the ratio of weight of cherries before and after pitting can be reduced by 5 to 10 percent for soft cherries. Damage to cherries in unloading, conveying and sorting reduces firmness and pitter efficiency that causes a low cherry pack out.

A 2200 gallon trailer tank was designed, constructed and tested in bulk handling 1400 bushels of mechanically harvested apples in high density and conventional orchards. Results showed that apples can be put into the bulk tank, transported and removed without bruising. Bulk handling can replace thousands of bulk boxes which cost \$25 each and are expensive to maintain and handle.

About 800 bushels of bulk handled apples were stored for 40 days in a silo-type storage. Temperatures were controlled by circulating outside air whenever it was 3°F. or more cooler than inside air provided it was not less than 32°F. Results showed that apples can be put into and removed from the silo at 3000 bu/man hour without damage and that apple quality can be maintained. Bulk storage can reduce storage costs and eliminate the need for boxes.

Pickling cucumbers were subjected in the laboratory to drops, vibration, and combinations of both. This data along with previous data showed pickles

should not be dropped over 4 feet and short drops should be kept under 5 drops to avoid bloating. This information is being used by industry in remodeling grading and handling lines at the plants and in transporting cucumbers.

Salinas, California: Cross country shipping tests were conducted to determine the feasibility of shipping lettuce in jumble-filled bulk bins (fiberboard). Bins were 22.5 feet³ capacity (10.5 carton equivalent) on a 35 x 42 slip sheet base. Because of the low density of lettuce, it is important that the equivalent or greater number of heads occupy the same volume as occupied for standard pack lettuce. We were able to attain as much or more (10.5 to 11.4 equivalent cartons) in each bulk bin. Evaluation at destination indicated that the quality in the bins was as good or better than in the standard pack cartons. There was a "loss of saleable" lettuce of approximately 20 percent in the cartons and 10 percent in the bins.

Riverside, California: The date pollen extraction unit was used commercially on 1800 acres by four growers last year. One additional unit was put in service this spring. The unit increases pollen recovery over hand methods by 15 to 40 percent while saving one worker for each 250 acres of date production.

A series of date storage tests were completed during the year. The tests involved a total of 72 bins of fruit harvested at three different times during the season and stored for periods ranging from 7 to 12 months under one of three temperatures. Results indicate lower temperatures at or below freezing improve fruit quality. Significant quality deterioration occurs if dates are stored at ambient conditions for more than 3 months. The industry has used the results for this year's crop and is now processing or placing fruit in cold storage within three weeks of harvest. A physical properties study of dates indicated that between date grades no single physical property differed sufficiently to be used as a parameter for sorting. A combination of properties such as force-deformation, moisture, and texture did indicate differences between grades.

A prototype vacuum wheel has been developed which uses force-deformation, texture and size as properties for sorting. A preliminary test of the sorter for determining three packing-house grades indicated a grading accuracy range of 50 to 78 percent. The packing house grade standards require 85 percent or greater accuracy. Improvements in the vacuum wheel sorter are expected to improve the sorting accuracy to 85 percent or above.

Corvallis, Oregon: Continued research and development on the friction-belt separator showed that modifications of this device could be used to separate soil clods and rocks from dry beans, weed seeds from alfalfa or clover, and rough surfaced seeds from smooth surfaced seeds. Tests were conducted on belt and separator bar materials, belt width, feed rate, and belt wear for friction separators that could be used for small seed sorting and cleaning. A small friction separator was constructed, evaluated and is now being used in the seed laboratory.

Evaluation tests with the verticle rotary screen separator showed that small inert material could be efficiently removed from cottonseed at high feed rates. A vertical rotary screen was attached to a combine to evaluate the seed cleaning effectiveness during harvesting of small seed crops. Results show substantial improvements over conventional harvesting equipment for crimson clover, alta fescue, annual ryegrass, and wheat.

Pneumatic separators were evaluated in the laboratory and on combines in the field. In the laboratory it was possible to separate ryegrass seed from foxtail seed and sweet vernalgrass seed, mature trefoil seed from immature trefoil seed, and beet seed from morning glory seed. Removal of weed seeds and inert materials from crimson clover, alta fescue, annual ryegrass and wheat seeds was successfully accomplished with the combine mounted pneumatic separator.

Tifton, Georgia: The relative merits of preserving millet by ensiling with that of dehydrating and pelleting was begun. The millet was cut with a mower-crusher and allowed to field wilt to about 65 percent moisture content. It was then picked up with a forage harvester and either ensiled or dehydrated and pelleted. The dry matter loss in the dehydrating and pelleting process amounted to 6.8 percent. The dry matter losses for the ensiled millet will be determined as the silage is removed from the silo. Both methods of preserving will be evaluated by feeding to dairy heifers.

Ensiling was compared with drying and pelleting arrowleaf clover which was overseeded on a permanent sod of Coastal bermudagrass. In addition to providing an evaluation of the two methods, the overseeding study provides a measure of the total production per acre of the two crops. In 1975 the clover yielded 2.7 tons of dry matter per acre and the Coastal bermudagrass 4.0 tons d.m. for a total of 6.7 tons d.m. per acre. This compares with 4.9 tons d.m. per acre for Coastal bermudagrass alone. The stand of Coastal bermudagrass was severely reduced by the combination of the seeding practice used and the shading by the clover in later April and early May. By late July, however, the Coastal bermudagrass stand was re-established.

Six commercially available peanut varieties and three advanced breeding lines were evaluated for tolerance to adverse drying condtions. The peanuts were dug and allowed to dry in an inverted windrow until the moisture content had reached about 20 percent. Following combining the peanuts were mechanically dried, using temperatures of either 95°F. or 110°F. with recommended air flow rates, to a moisture content of 10 percent. The peanuts were then shelled and the split and bald kernels determined. In general the Spanish varieties showed a threefold increase, the Runner about twice as many and the Virginia type about a 50-percent increase in these damaged kernels due to the 15°F. increase in drying temperature.

Peanuts were dug, inverted and dried in the windrow to about 23 percent moisture content. They were then combined and loaded into drying bins. Four replications were made of each of three treatments, i.e. conventional, heat

supplied by LP gas, LP gas assisted by solar heated water, and solar heated air only. The conventional and the solar heated water treatments dried a safe moisture level (10 percent) in about 44 hours. Since no heat storage was available for the solar heated air, 94 hours including 6 hours on LP gas to reduce moisture from 11.5 to 9 percent moisture content, were required for drying. In these tests solar energy supplied from 40 to 85 percent of the heat energy required.

A non-reversing heat pump, operated under standard supplemental heat procedures with the humidity set at 65 to 70 percent, was used to dry peanuts from 26 percent moisture to 10 percent moisture in 49 hours. All aspects of the test were favorable except efficiency. The average energy efficiency ratio (EER) was only 5.5 BTU per watt and the coefficient of performance (COP) was 1.62. The system was redesigned and the EER increased to 9-11. As the system capacity increased, the EER decreased. For example, increasing the capacity from 22,700 BTU/hr. to 24,800 BTU/hr. decreased the EER from 10.6 to 8.0.

Four flat-plate, 32-ft² solar collectors, using air as the heat transfer medium were designed, constructed and tested. These were used to supply energy to drying bins which contained approximately 450 pounds of peanuts (20 percent moisture content). Auxillary heat, from electric resistance heaters, was used at night only. Air flow rates of 12, 17, 22 and 28 cfm/ft² were used. Using these air flow rates, the time required to reduce the moisture content from approximately 17.5 to 7.5 percent varied from 25 to 48 hours.

Byron, Georgia: Very small fruits and other objects under 1 inch in diameter are eliminated to the ground through the horizontal conveyor on the continuous-moving harvester, and air directed from a blower to the discharge end of this conveyor removed some of the light trash. In the first commercial orchard run, some leaves and sticks had to be removed from the mechanically harvested fruit at the packing shed which is undesirable. Additionally, the sticks are a source of damage to the fruit. The on-machine system for handling fruit in which four 18-bu. boxes were carried, and filled boxes gravity lowered to the ground at the rear, and empty boxes loaded by hand from the side of the machine, was satisfactory when tree rows were short.

Among several arrangements tried for de-burring freshly tree-harvested Chinese chestnuts, one using a rotating rubber tire spaced about three-fourths of an inch from a rigid surface covered with three-eighths rubber belting material, was successful without causing significant damage to nuts.

Lexington, Kentucky: Moisture sorption and desorption of bulk-cured and stalk-cured burley tobacco were measured. For bulk-cured tobacco the sorption rates were about one-third the desorption rates. A deep layer drying analysis was made of burley tobacco curing. Temperature and r.h. within the mass of tobacco is predicted as a function of outside temperature, r.h., and air velocity. This analysis is a major component of a computer

prediction model to describe the environment within a conventional tobacco barn. A two-stage curing system consisted of (1) extended field curing using solar energy to promote yellowing, and (2) finish curing in a solar curing barn. Extended field wilting experiments were conducted. Results showed that during cool weather solar heating in the field improved quality, whereas tobacco in the barn cured green due to low temperature. Two days of solar field curing increased both support and market price by 10¢/lb. compared to barn curing.

Density of compressed bales of oriented burley leaves was determined as a function of compression load, leaf moisture content, and stalk position. The results showed that for a given compression force, density was highly affected by moisture content and moderately affected by stalk position. Density of baled leaves from the lower stalk position was doubled from 9 to 18 lb/ft³ by increasing moisture content from 13.5 percent (wet basis) to 27 percent at a constant compression pressure of 350 lb/ft². Density of the leaves from the lower stalk position was consistently lower than that of the upper stalk position for the same compression force.

The optimum spacing of cutters for slicing stalks of cured burley tobacco was determined. A balance was made between minimum losses of leaf material and maximum sizes of leaf strips to be used for pneumatic separation studies. A laboratory prototype stalk slicer was designed, fabricated, and operated for preliminary studies of feed rates and cutter speeds. Prototype baling chambers were designed and tested in the stripping room. The dual-direction compression principle did not produce adequately uniform bales with one-stroke compression.

PUBLICATIONS

East Lansing, Michigan

Tennes, B. R., Harrington, W. O., J. H. Levin and G. M. Sapers. Evaluation of in-orchard mixing of pre-packaged brine. ASAE Microfiche 75-3030, June 1975.

Tennes, B. R., W. O. Harrington, J. H. Levin and G. M. Sapers. In-orchard brining of sweet cherries using a pre-packaged powder. Research Report 295, Agr. Expt. Station, East Lansing, Michigan, March 1976.

Marshall, D. E., J. H. Levin, D. R. Heldman, L. R. Baker. Specific gravity studies of pickling cucumbers. Hort. Science 10(3):319 (Abstract), 1975.

Marshall, D. E., A. W. Hooper, L. R. Baker, D. R. Heldman. A method for measurement of carpel strength in cucumbers. Trans. of ASAE 18(4):752-754, 1975.

Sarig, Y., L. J. Segerlind, D. E. Marshall, J. H. Levin, D. R. Heldman. The effect of cucumber handling on brine stock quality. ASAE Microfiche No. 75-6504, June 1975.

Salinas, California

R. E. Garrett and D. H. Lenker. Selecting and sensing X and gamma rays. ASAE Publication 1-76 quality detection in foods, January 1976.

P. A. Adrian, D. H. Lenker and D. Nascimento. Concepts and developments of an experimental trimmer for crisphead lettuce. ASAE Transactions, 1976.

D. H. Lenker, P. A. Adrian and D. E. Wilkins. Development of a mechanical cauliflower selector. ASAE Transactions, 1976.

Riverside, California

Chesson, J. H. and P. F. Burkner. Preliminary investigations for Jojoba harvesting. Accepted for publication in the Transactions of ASAE, Feb. 1976.

Burkner, P. F. and R. M. Perkins. Mechanical extraction of date pollen. Date Growers' Institute Report 52, 1975.

Corvallis, Oregon

Brandenburg, N. R. Cleaning problem seed lots. Proceedings, Seed Processors Conference, OSU, March 11-12, 1975.

Park, J. K. Friction Separator. Proceedings, Seed Processors Conference, Oregon State University, March 11-12, 1975.

Brandenburg, N. R. Magnetic separation of seeds. Technical Bulletin, Oregon State Univ. Agric. Experiment Station (submitted for NTE review March 1976)

Tifton, Georgia

Utley, P. R., R. E. Hellwig and W. C. McCormick. Finishing beef cattle for slaughter on all-forage diets. J. Animal Science, Vol. 40 (1975), No. 6, pp 1034-1038.

Utley, P. R., R. E. Hellwig, J. L. Butler and W. C. McCormick. Processing and feeding bermudagrass pellets fortified with soybeans and urea. Research Report No. 205, Georgia Coastal Plain Experiment Station, April 1975.

Butler, J. L. and J. M. Troeger. Considerations for solar drying of peanuts. Proceedings of American Peanut Research and Education Association, Inc. 7(1) p 76, 1975.

Butler, J. L. and J. M. Troeger. Application of solar energy for peanut drying and curing. American Society of Agricultural Engineers, Paper No. 75-3505, 1975.

Butler, J. L. Using solar energy in agriculture. Proceedings of Southern Regional Education Board Conference-Workshop on Energy in Agriculture, 1975.

Byron, Georgia

Peterson, D. L. and G. E. Monroe. Continuously moving shake-catch harvester. ASAE Paper No. 76-1052, 1976.

National Research Program Annual Report 20190

IMPROVED METHODS AND EQUIPMENT FOR PRODUCTION OF FIELD,
FIBER, AND HORTICULTURAL CROPS

Technological Objective III.3: Develop improved equipment and techniques for tilling, planting, transplanting, fertilizing, and cultivating to increase production, reduce labor and machinery costs, reduce fossil fuel use, and improve harvesting efficiency.

Deep placement of fertilizer in strip mine spoil banks with experimental equipment improved stand establishment. Double band placement of fertilizer gave better yield response for forage seedings than other application methods. Experimental equipment and methods to prevent wheel traffic in production rows resulted in reduced soil density, increased water infiltration and increased yields of cotton. Uniform shallow planting and removal of compaction by tractor wheels improved soybean stands and yields.

Use of improved transplanting equipment resulted in better stand establishment, more uniform plant spacings than direct seeding lettuce, cauliflower, grass and tobacco. Use of experimental equipment and techniques for pruning fruit trees reduced labor costs and increased yields.

Following are some examples of recent progress:

Beltsville, Maryland: Deep placement of lime and fertilizer has been accomplished on strip mine spoil banks by means of special developed equipment in cooperation with Biological Waste Management and Soil Nitrogen Laboratory, PPHI (6). Dolomitic limestone and rock phosphate were placed at depths of 4, 10 and 16 inches and the area was seeded to a mixture of Kentucky 31 tall fescue and birdsfoot trefoil.

Efficiency studies on fertilization of bush beans showed marked difference among methods of application, irrigation practices and form of fertilizer applied. Without irrigation following planting, single-band fertilization efficiency was markedly lowered and double-band fertilization produced much better. With irrigation to effect band dissolution, the two methods were equally effective. Mechanical dispersion of the band or broadcasting before planting was less effective. The former approached the efficiency of a single-band when irrigation was delayed following planting. Broadcasting and incorporation of fertilizer before planting was only 50 percent as effective to band fertilization.

Urbana, Illinois: An experiment to evaluate the effect of planting depth (1,2, and 3 inches) seed treatment with fungicide, and variety of soybeans was continued in cooperation with L. E. Gray of the U.S. Regional Soybean Laboratory. The results of two years data indicate that under wet soil conditions shallow planting and seed treatment are of value in establishing target stands of soybeans.

Both of the new herbicides (metribuzin and bentazon) have shown considerable potential for controlling weeds in soybeans with normal rainfall patterns. However, weed problems can develop in soybeans planted in rows too narrow for cultivation with adverse weather conditions. Corsoy variety of soybeans provided a 12 to 23 percent yield increase in 7-inch rows when compared to 30-inch rows. When pulled behind a tillage tool to remove tractor tire tracks, both the end-wheel drill and the press-wheel drill were satisfactory for planting soybeans and obtaining target stands. When used with a press-wheel drill, a planter harrow was as effective for seedbed preparation as a packer mulcher.

East Lansing, Michigan: Late winter shake pruning of pear tree studies were completed and proved to be low cost (50¢/tree versus \$2/tree for conventional method) and an effective method of pruning. New growth was stimulated and shake pruning resulted in higher yielding trees of larger size pears.

An improved tree planter which performs the complete planting job was designed, built and used to plant 150 acres of cherries, peaches and apples in 6 Michigan locations. Trees were planted 10 times faster than conventional one-tree-at-a-time methods and reduced costs by 90 percent. Trees planted by 4 different methods will be evaluated for tree vigor and life.

Shafter, California: The effect of wheels on soil strength was reasonably constant after the first year. A zone 20 inches wide extending from the surface to 16 inches and centered under the tire had higher strength than corresponding zones without wheels. The total volume of soil available to roots with strength less than 200 psi was 50 percent greater where no wheels were operated, and subsoiling operations required 15 percent less draft. Water infiltration rate was 44 percent higher for no wheels. Surprisingly, eliminating wheels reduced the verticillium population (50 percent) and pythium population (80 percent) in soil. Cotton yields were 6 percent higher for two years, the same for one year, and 2 percent lower for one year. Removing wheels from production system changes many of the environmental characters of the soil-plant relationship. The soil factors indicate a potential for substantial reduction in production costs, both direct applied energy and indirect energy such as water. The variation in yields appears to be related to the differences in environment between the two systems.

Salinas, California: For Chualar loam soil lettuce seedling stand was linearly correlated in a positive manner with soil aggregate sizes of 8-16 mm and 16-32 mm but negatively correlated with aggregate sizes below 0.5 mm. Drip irrigation was used to grow lettuce in wide beds (six rows in one eighty inch bed) and conventional beds (two rows in one forty inch bed). The wide beds produced significantly smaller and more uniform heads than the conventional beds. Lettuce seedlings grown in transplant containers under ideal environmental conditions resulted in not significantly improving harvest head uniformity but did significantly alter the root structure and shortened the time to reach harvest maturity as compared to direct seeded lettuce. Cauliflower (Snowball-y) seedlings grown in transplant containers and subjected

to day lengths of 8 or 15 hours and temperature depression of 0° or 20°F. prior to transplanting resulted in not significantly affecting harvest quality or uniformity but did increase the number of harvestible heads by 30 percent over direct seeded cauliflower.

Temple, Texas: The small size of grass seed and the slow germination and emergence rates make it difficult to keep sufficient moisture in the seed zone long enough for successful establishment. Greenhouse tests confirmed the vital importance of moisture to emergence. To circumvent many of the difficulties with seeds, some initial trials were run planting crown material from Kleingrass 75, Lovegrass, Old World Bluestem, and Eastern Gamagrass. With weekly waterings equivalent to 1 inch of rainfall, the crowns all started to grow rapidly, attaining 18 inches of height in a month as compared to 1 to 2 inches of growth from seeds planted at the same time. Crowns planted in 50 percent soil, 50 percent vermiculite seemed to start growing and to grow faster than crowns planted in 100 percent soil. It was found that the root masses from the bunch grasses dug up for plant material could be sawed into "plugs" by a powered band saw. The plugs of from 1"x1" by 3" to 4" long up to 2"x 2" by 3" to 4" long grew readily when planted in pots and watered.

Lubbock, Texas: Plot yields from treatments with the greatest spacing uniformity yielded 55 lbs. more lint/acre than treatments with the lowest uniformity. Plants manually "desquared" beginning 68 days after emergence produced 698 pounds lint/acre compared to 651 for uncontrolled plants. Controlled fruiting increased yield 7 percent. Preliminary work with a first square simulation model showed the binomial distribution described the nodal distribution of first squares. Dams maintained in the furrow during the growing season increased dryland cotton yields 10 to 25 percent.

Stoneville, Mississippi: In comparing a standard wedge-subsoiler with a 30-inch winged subsoiler on both 40-inch conventional beds and 2.5 meter wide beds, the operation of a single 30-inch wing-type subsoiler in the center of wide beds was superior to subsoiling with two 30-inch wing subsoilers per wide bed and conventional subsoiling on 40-inch beds. Yields of cotton on 90-inch and 98-inch wide beds were equal to those on conventional 40-inch beds. Yields from 104-inch and 110-inch wide beds were reduced from that of 40-inch beds by 12 to 15 percent, respectively. Total yield of seed cotton was not affected by different fertilizer rates of 60 to 90 pounds of N per acre on both 98-inch wide beds and 40-inch conventional beds. In determining the effects of different plant populations on 98-inch wide beds and 40-inch conventional beds, the higher populations of 60 to 80 thousand plants per acre tended to mature faster than lower populations. Twin drill planting patterns (7-inch spacing) had no effect on total yield. Foreign matter content in cotton lint increased as plant population increased. In comparing 9 tillage treatments on Sharkey clay soil for soybeans, additional tillage beyond conventional disking and harrowing operations produced greater yields in both wide-bed and conventional-row patterns. Wide bed, spring-tilled plots produced highest yields although superior stands were obtained on conventional 40-inch rows.

Mississippi State, Mississippi: Soil strength and bulk density measurements were taken before cotton harvest. The data showed increased soil strength and higher bulk density readings under the tractor wheels and significantly lower readings in the subsoiled zone. There was no significant interaction between row spacing and type of traffic in 1975 for any of the yield, harvester efficiency, or fiber property data obtained. The cotton grown in standard 40-inch rows significantly out-yielded the 7-inch twin-drilled cotton, 586 pounds to 425 pounds of lint per acre, and was considerably easier to harvest than the twin-drilled cotton. The 40-inch single row cotton also had significantly higher length (1.109 to 1.095 inches) and less foreign matter than the twin drilled cotton. Other fiber properties were not significantly affected by treatment.

A cotton crop model (COTCROP) was completed which predicts growth and yield of a cotton crop based on weather, soil and insect factors. Preliminary validation efforts show that the model adequately simulates growth and yield for conditions of adequate soil moisture and nitrogen. A complex boll weevil population dynamics-crop interaction model was simplified for use in a cotton crop-insect pest simulation model. The resulting model, BWEEV, runs in less than one minute for a season compared with about 9 minutes required by the detailed simulation. An error analysis indicated that the simplified model can be used with acceptable accuracy.

Belle Glade, Florida: Seedpiece lengths of sugarcane 40 to 50 centimeters long placed in the furrow and covered in a separate field operation produced higher yields than other spacings and covering methods. Experimental planting equipment will be constructed to meet these performance criteria and the planter will be evaluated under field conditions.

Tifton, Georgia: Arrowleaf clover was overseeded on Coastal bermudagrass sod by close cropping the grass in October, harrowing and seeding with a grain drill. A fair stand of clover was obtained and total forage yield for the year was increased. The stand of Coastal bermudagrass, however, was severely reduced and recovery of stand was not made until July.

Three varieties of peanuts, representing the three major types, were planted in two different row patterns. One was the conventional modified 36" row (32" on the bed and 42" in the middles). The other consisted of six rows spaced approximately 7 inches apart (with tractor wheels set on 72 inches). For each of the three types, the six row pattern out yielded the conventional by about 15 percent. This was done under much drier than normal conditions.

Six methods of peanut land preparation were evaluated. The methods were (a) chiseling (14-15 inches) randomly with respect to the row, followed by deep turning, (b) deep turning and chiseling in the same operation, (c) deep turning followed by under-row subsoiling and disk bedding, (d) deep turning followed by under-row subsoiling with a coulter (to cut through buried residue), (e) under-row subsoiling followed by chiseling, and (f) deep turning alone. The growing season was characterized by almost continuous moisture stress. There were no significant differences in yield due to the treatments.

Studies in the Sind province of Pakistan showed that the production efficiency was greatly improved by mechanization. These studies conducted by the survey method were on wheat, cotton and sugarcane. For wheat, the productivity of grain per acre was 32 percent higher on the mechanized farm than the traditional farm. The total revenue from the mechanized farm was Rs. 1370 per acre compared with Rs. 1050 per acre from the traditional farm. On the average the mechanized farmer earned 30 percent more income than the traditional wheat farmer. For cotton, the productivity of the mechanized farms was 35 percent higher than the traditional farm. The revenue productivity was Rs. 1715 per acre and Rs. 1233 per acre for the mechanized and traditional farms respectively. The yield of sugarcane was 22 percent higher on the mechanized farms than on the traditional. Gross value per acre averaged Rs. 4904 for the mechanized farms and 4006 for the traditional farms.

Byron, Georgia: The oversize mower cutterbar pruner was further tested both on and off station. The machine has been used to mechanically prune a large part of the peach, plum, and apple trees and some pecan trees on the station. Total usage of the pruner to date has shown that the shaker vehicle used to carry and power it is not well suited for this purpose. Continued studies on tree shaping for mechanical harvesting indicate that "Y" shaped trees are first set up with the standard vase shape and then modified to the "Y" shape after they are 3 to 4 years old.

Lexington, Kentucky: A review was conducted of the theory and methods for investigating critical microenvironments for mulched transplant seedlings. Field plot study of tobacco transplant temperatures was continued using cultivated, mulched, and no-tillage conditions. Leaf psychrometers were used to correlate leaf temperatures and water tensions. Burley transplant-size studies were continued for their effect on survivability, and growth and yield uniformity for no-tillage culture. The prototype no-tillage transplanter continued to operate satisfactorily.

PUBLICATIONS

East Lansing, Michigan

Tennes, B. R., J. Breinling, R. Carlson and J. H. Levin. Mechanical pruning of dormant pear trees, ASAE Microfiche 75-3027, June 1975.

Salinas, California

Wilkins, D. E., W. G. Lovely and E. C. Berry. Foam application for corn-borer control. Transaction of the ASAE, Vol. 18(2):1975.

Lubbock, Texas

Wanjura, D. F., R. F. Colwick and J. W. Jones. Status of cotton-production system modeling in Regional Research Project S-69. 1975 Proceedings Belt-wide Cotton Production Research Conference, p. 159-161.

Wanjura, D. F. Emerge: A simulation of cotton germination and emergence. In computer simulation of a cotton production system: Users Manual. ARS-S-52, pp 12-22, 1975.

Mississippi State, Mississippi

Bacheler, J. S., J. W. Jones, J. R. Bradley, Jr., and H. D. Bowen. 1975. Influence of temperature on abscission of cotton squares infested with boll weevil eggs. J. Econ. Entol. 68(3): 298-300.

Jones, J. W., H. D. Bowen, R. E. Stinner, J. R. Bradley, Jr., R. S. Sowell, and J. S. Bacheler. 1975. Female boll weevil oviposition and feeding processes: A simulation model. Env. Entomol. 4(5): 815-21.

Jenkins, Johnie N., W. L. Parrot and James W. Jones. 1975. Boll weevil oviposition behavior: Multiple punctured squares. Env. Entomol. 4(6): 861-7.

Jones, J. W., H. D. Bowen, J. R. Brandley, Jr., R. E. Stinner, and R. S. Sowell. 1975. The boll weevil feeding process: A simulation model. Ecol. Modelling 1:289-302.

McKinion, J. M., J. W. Jones, and J. D. Hesketh. 1975. A system of growth equations for the continuous simulation of plant growth. Trans. ASAE 18(5): 975-9, 984.

Bacheler, J. S., J. W. Jones, J. R. Bradley, Jr., and H. D. Bowen. 1975. The effect of temperature on development and mortality of boll weevil immature stages. Env. Entomol. 4(5):808-10.

Tifton, Georgia

Butler, J. L. and J. M. Troeger. Considerations for solar drying of peanuts. Proceedings of American Peanut Research and Education Association, Inc. 7(1) p 76, 1975.

Butler, J. L. and J. M. Troeger. Application of solar energy for peanut drying and curing. American Society of Agricultural Engineers, Paper No. 75-3505, 1975.

National Research Program Annual Report 20190

IMPROVED METHODS AND EQUIPMENT FOR PRODUCTION OF FIELD,
FIBER, AND HORTICULTURAL CROPS

Technological Objective III.4: Develop equipment and facilities to control environmental factors that affect crop production in greenhouses, in plant growth rooms, and in the field.

Air-supported greenhouses were successfully operated continuously for 15 months. Plant growth in growth chambers was responsive to light wave lengths of 425, 550, and 650 nm for a wide range of temperature and CO₂ conditions. Experimental results show that 78 percent of greenhouse heat requirements can be provided by solar energy. Plant response was greatest for light wave lengths of 425, 550 and 650 nm provided by sodium, mercury, and multivapor HID lamps in growth chambers. Air-supported greenhouses offer potential as low-cost structure. Approximately 1/2 the radiation required for plant growth in greenhouses was economically provided by using LPS lamps. Plastic and paper films used as mulches in outdoor plantings modified the environment and reduced insect infestation.

Following are some examples of recent progress:

Beltsville, Maryland: Performance tests of the 12 ft. x 16 ft. x 10 ft. air-support greenhouse with a power pack were completed. The power-pack design was found to be adequate for support of the structure and maintenance of the environment within the range of plant growth for year-round operation. The air-support greenhouse, after 15 months of continuous operation was discontinued November 26, 1975. The structure withstood all weather conditions, including two severe storms of December 1, 1974 and April 1, 1975, during which the wind speed was 30-35 and gusts to 60-65 mph. The power pack includes a 3/4 hp 4-speed blower, a 15 kW duct heater (51,000 Btu-hr), a 60 ft² wet pad, and a 60 ft² air-tempering, solar panel assisted by a 3 ft. x 6 ft. aluminum reflector. The temperature inside the structure has never been below 40°F. or above 90°F. throughout the period of test.

The spectral composition of the light environment for each of 200+ plants was determined from irradiance measurement and spectral characteristics of each of the three light sources, sodium, mercury, and multivapor HID. The spectrum from 400 to 700 nm was divided into twenty 15 nm sections and these were used as independent variables in multiple regression analyses with yield as the dependent variable. A plot of the regression coefficient against wave length indicated 3 active regions, 425, 550, and 600-700 for all experimental conditions of temperature, CO₂ and species. The 24 ft. x 40 ft. headhouse-greenhouse module has 480 ft² of opaque collector, 2500-gallons of water and 63 tons of rock as storage media. At Beltsville it was estimated that the greenhouse has a heat loss coefficient of 19200 Btu DD⁻¹ with an annual total of 99.2 MBtu. Of this total, 78 percent is provided from solar energy system, while 22 percent must come from an auxiliary source. Cooling through nocturnal evaporation at 1.5 gallons of water per hour would produce one ton of refrigeration

(12,000 Btu hr⁻¹). Taking advantage of day and night energy cycle conserves and reduces the cooling requirements.

Lettuce seedlings were grown in 3-, 4-, and 5-inch pots for up to 35 days with sequential harvests every 5 days. Growth chamber conditions were 10 Klux of Westinghouse Agrolite fluorescent light for 16 hours, temperature 30 C day and 27 C night, and CO₂ level of 1,000 PPM. By the 15th day there was a slight reduction in size and weight of plants in the 3-inch pots. By the 20th day, plants in 5-inch pots were significantly larger and heavier than those in 4-inch pots, and those in 4-inch pots were larger than those in the 3-inch pots. Also, the growth rate in terms of gms increase/gm of both fresh and dry weight gradually decreased as the plants became larger.

Total radiation in the wave-length region 400-850 nm without spectral preference was found the dominant factor in vegetative growth of plants, (in cooperation with Ornamentals Laboratory, PGGI).

In controlled environment chambers cool-white fluorescent (CWF), low-pressure sodium (LPS), and high-pressure sodium (HPS) were compared at energy levels of 80 watts per meter (400-850) nm with and without incandescent radiation to determine relative growth of plants. Although the light sources were spectrally different the plants were similar in height, number of nodes, and fresh weight.

CWF, LPS, and HPS radiation without incandescent was equally effective in promoting growth of most plants. The addition of incandescent increased the weight of the plants without altering node numbers or weight of plants. Lettuce developed pale yellow leaves and lengthened internodes when grown under LPS as a sole source, but the growth was equal to the HPS and CWF when incandescent radiation was included.

A modular supplemental greenhouse lighting system was developed using LPS lamps in low profile luminars. Radiation was 40 watts per nm in the 400-850 nm wave-length region. The lighting system operated 16 hours a day supplying about one-half the radiation required by the plants. The remaining radiation for plant growth and development was provided by normal greenhouse daylight. More than 100 species grew and developed as well in the greenhouse under the lighting system as in growth chambers. Flowering and fruiting required 80 percent of days normally expected in outdoor plantings.

Other studies with various fluorescent lamps including the special spectrum for plants and special incandescent lamps indicate that vegetative growth is directly related to total energy emitted in the 400-850 nm region. Incandescent lamps alone resulted in elongated stems and pale colored foliage.

In outdoor vegetative plantings three films, black polyethelene, reflective coated polyethylene and paper backed aluminum foil, were compared for effectiveness in reducing insect damage and total production of crop. All films improved crop production and reduced insect damage. One season was not considered adequate to determine relative effectiveness of the three films.

Shafter, California: The interaction of soil moisture and fungicides on cotton emergence diseases was studied in cooperation with Dr. Garber, Plant Pathologist. A special planter was designed and built utilizing the basic moisture-seeking planter described in past reports. An unpredicted rain occurred the day following plot application and removed the moisture variable. Therefore only the main effect of seed treatment was left and the results were essentially the same as in prior pathology tests: 3 percent, 24 percent, 56 percent emergence for no seed treatment, 3 ounces Dexon plus 10 ounces Demosan and 3 ounces Dexon plus 16 ounces Benlate plus 16 ounces L21 per hundredweight of seed.

PUBLICATIONS

Beltsville, Maryland

Liu, R. C. and G. E. Carlson. 1975. Solar energy utilization in greenhouses: Principles of Plant Environment Interrelationships. ASAE Paper 75-4023.

Liu, R. C. and G. E. Carlson. 1975. Concept for use of solar energy in greenhouses. *Energies* 1(5):10-11(Dec.).

Liu, R. C. and G. E. Carlson. 1976. Proposed solar greenhouse design. Proceedings of ERDA-ARS Solar Energy, Fuel and Food Workshop. EKL Univ. of Arizona, Tucson, Arizona (In Press).

Liu, R. C. 1976. Solar energy utilization: A bibliographic guide. ARS-NE74, 40 pp. (June 1976).

Campbell, L. E., Thimijan, R. W., and Cathey, H. M. Spectral radiant power of lamps used in horticulture. *ASAE Trans.* 18(5):952-956.

Cathey, H. M., and Campbell, L. E. Security lighting and its impact on the landscape. *J. Arboriculture* 1(10):181-187.

Cathey, H. M., Smith, F. F., Campbell, L. E., Hartsock, J. G., and McGuire, J. U. Response of *acer rubrum* L. to supplemental lighting reflective aluminum soil mulch and systemic soil insecticide. *J. Amer. Soc. Hort. Sci.* 100(3):234-237. 1975.

Jaworski, C. A., Hulburt, W. C., Dudley, R. F., and Jones, J. B. Field production of southern tomato transplants with various nutrient rates, forms, and placement. *Hort. Science Journal* 10(2):14. April 1975.

SPECIAL RESEARCH PROGRAM ANNUAL REPORT

TITLE: Production and Control of Narcotic Plants

NUMBER: Under NRP 20160

MISSION: Affect the production economics of illicit narcotic crops so as to give licit agricultural enterprises a competitive advantage and, secondly, assure that the United States has an adequate and stable supply of raw materials to meet its medical needs for codeine at reasonable cost.

TO 1. Reliable research information on agricultural enterprises which will provide economically viable alternatives to growers of illicit narcotic crops.

Chiang Mai, Thailand

Project proposals originate with Thai scientists, are reviewed in Thailand by the Highland Agricultural Research Coordinating Committee (composed of two permanent members from each of the following organizations: Kasetsart University, Chiang Mai University, Department of Agricultural Technology, Royal Forest Department, Applied Scientific Research Corporation of Thailand, United Nations Program for Drug Abuse and Control, and Agricultural Research Service offices of USDA) and are reviewed in the United States by appropriate scientists of the National Program Staff of the Agricultural Research Service. Semiannual payments to contractors are contingent upon demonstrated progress toward project objectives. Onsite technical support and guidance is provided by the Agricultural Research Officer stationed in Chiang Mai near the poppy growing area. Technical backstopping is provided by ARS scientists in the United States and through visit of expert consultants on specific problems.

Extension of research findings will be accomplished through the Thai/UN demonstration-extension program, the office of extension in the Tribal Research Center of the Department of Public Welfare and through the King's Hill Tribes Project. The King supports the crop substitution program with funds and openly praises the USDA program in Thailand.

The results of this ARS-sponsored research could apply to nearby Burma where edaphic and climatic conditions are similar.

Projects which have shown notable results are:

Deciduous Fruits - The feasibility of improving yield and quality of native fruit trees by grafting superior varieties (imported from United States and Australia) on to wild rootstock has been demonstrated. Grafted peach and nectarine plants and budwood for grafting are going to the villagers.

Coffee - Plantings of rust resistant arabica coffee have been established in several areas and appear well adapted. Cultural research continues and could result in the establishment of a sound commercial coffee enterprise. Cultivation of coffee would provide much needed employment for the villages and would discourage the unstable swidden agriculture now practiced by the Hill Tribes.

Mushrooms - Both shiitake and button mushrooms can be grown successfully in the poppy growing areas. A well-established market for fresh and canned mushrooms exists in Thailand and a good export market can be developed, especially for the highly prized shiitake. The process of drying mushrooms is not sophisticated and will facilitate marketing from remote areas.

Essential Oil Crops - Plantings of several essential oil producing crops have been established in the poppy region and a small distillation plant is in place. Thailand imports almost all of its essential oils. The decline in production of essential oils in high labor cost countries of Europe encourages an export market.

Strawberries - After 2 years of research, this crop looks exceptionally good for the Hill Tribes area. Since strawberries are a perishable fruit, emphasis is on production of daughter plants during the wet season for planting in the lowlands during the cooler dry season. When roads are built into the area, the Hill Tribes can supply fresh strawberries for the off-season market.

Pyrethrum - This plant produces pyrethrins, the best of the natural insecticides. Pyrethrin insecticides have a low mammalian toxicity, are biodegradable, and have a powerful knockdown effect on a wide range of insect species. Yields from the first year's crop reached 745 pounds of dry flowers per acre which compares most favorably with the average yield of 400 pounds per acre in Kenya, the world's major producer.

Pakistan

The crop substitution research program in Pakistan operates along the same lines as the one in Thailand except that Special Foreign Currency Funds are used to support research grants. Eleven research projects are presently active in Pakistan. Four of these were initiated within the past year and none have been in operation for as long as 3 years.

Pome Fruits - The northern zone of Pakistan is between 30 to 37 degrees north latitude with elevation ranging from sea level to 3,000 meters. The soil and climate are ideal for the cultivation of temperate fruits and nuts. Current production does not meet local requirement. With the completion of several irrigation schemes, the acreage devoted to fruit and nut crops will increase. The establishment of permanent tree crops will discourage opium poppy production. Research is needed if a sound industry is to develop. The research project was instrumental in introducing dwarf apple trees of adapted varieties for the first time. Several imported varieties of fruits and nuts have been grafted on to dwarf stock for planting in the mountainous poppy producing areas. Preliminary results of this research are most encouraging.

Sugarbeets - About 30,000 acres are devoted to sugarbeets production and this will increase to 70,000 acres when a fourth sugar mill is completed. This acreage will require 350 tons of seed most of which is imported, requiring a heavy expenditure of foreign exchange. The seed producing potentials in the Swat and Parachinar Valleys (both important poppy producing areas) are excellent. High yielding varieties of sugarbeets have been supplied and a breeding program has been initiated to develop suitable varieties for Pakistan. Work is also being supported to develop bullock drawn equipment to improve the efficiency of planting, tilling, fertilizing, irrigating, and digging sugarbeets.

Chickpeas - The chickpea is the least expensive source of protein in Pakistan. About 2 2/3 million acres are devoted to the production of chickpea. The acreage could be expanded in the poppy producing area if disease resistant varieties can be developed. Lines resistant to blight discovered in introductions obtained from USDA are being increased for introduction into the poppy area of the North West Frontier Province. This crop could replace considerable acreage of opium poppy.

Safflower - Pakistan is deficient in the production of edible oils with annual deficits of 100,000 tons. It is becoming increasingly difficult for Pakistan to obtain oil for food from the world market. The acreage of safflower is limited in Pakistan because of disease problems. The research project involves breeding and agronomic studies to develop suitable types that will grow in the winter on land now devoted to poppy production.

Turkey

1. The development of the world's first winter lentil. This crop is sown in the fall and harvested in early summer, as is the poppy, and will return more cash income per unit area than the poppy. As seed becomes available, more and more farmers are growing it in place of the traditional summer lentil.
2. The development of the world's first winter safflower (oilseed). This new safflower variety has excellent winter hardiness and is highly productive. Present indications are that it will give higher yields of oil per acre on dry land than sunflower will in the same area on irrigated land.
3. New oat varieties that are truly winter hardy and give higher yields than spring oats.
4. Three new wheat varieties that are from 12-25% better than the best present varieties.
5. Winter malting barleys that are superior in yield and quality to presently grown varieties.
6. Cropping practices and rotation systems which permit drastic reduction of fallow periods and hence more production (income) per unit area per year.

Spin-off benefits to U.S. agriculture from this research will of itself repay many times over the U.S. costs of supporting this research.

Plant Taxonomy Laboratory, Beltsville, MD

Ecological, geographic, and agronomic data on 1,000 economic plants were entered into the System 2000 computer system and

TO 1 (Cont'd)

5

and a more flexible system tested to show that an analysis of the weed flora of an area could be programmed to define the ecological parameters of that area and to report which of the 1,000 economic plants in System 2000 could tolerate similar conditions. Such an approach can provide the first "cut" of prospective substitute crops that should be evaluated in a given area.

TO 2. New and improved knowledge of the botany, chemistry, and agronomy of narcotic plants and their products.

Industrial Crops Laboratory, Northern Regional Research Center,
Peoria, IL

Opium poppies grown in an environmental chamber produced terminal capsules which reached a maximum wet weight in 8-16 days after flowering. Codeine and morphine content of the capsules rose rapidly from flowering to 8 days later and then tended to level off as the capsules matured and dried. Final morphine content was 0.6 percent of mature capsule plus seed.

TO 3. Agricultural chemicals and biological agents for control of illicit narcotic crops.

Quarantine of Insects Research, Stoneville, MS

Shipments of Ceutorhynchus maculaalba were received as larvae, pupae, and adults. Larvae were allowed to emerge from one-third of the original capsules and were dissected out of the remaining capsules. Those dissected out were placed in capsules of growing plants or on artificial diets. Both the larvae left in original capsules and ones transplanted into growing plants emerged from the capsules and entered the soil. No pupal cells or adults were recovered from these. Some larvae developed into pupae in the artificial diets but they did not form pupal cells and did not develop into adults.

Pupal cells received were placed in 10 different environmental regimens and 4 different types of containers. The best environmental regimen for emergence was 21°C to 24°C day temperatures, 18°C night temperature, 70% day and 70% to 75% night humidity, and 12-15 hours of light. Adults that emerged in a plexiglass cage (1.56 m long x 1.28 m high x .78 m wide) with plants growing in pots setting on top of a 25 cm layer of soil appeared to be more active than ones emerging in smaller containers and transferred to single plant cages.

ANNUAL REPORT

1. Genetic Vulnerability of Crops.

2. This Special Research Program contributes to the Department's Mission 2, Agricultural Production Efficiency. The technological objectives are to (1) Improve the national system for collecting, maintaining, evaluating, documenting and distributing plant genetic resources chosen for systematic preservation, (2) Increase understanding of taxonomic, cytological, cytogenetic, and biochemical relationships among plant genetic resources, (3) Improve the national program to utilize plant genetic resources for the breeding of cultivars and breeding stocks with increased genetic potential for producing high yields of good quality product with minimum losses from pest and environmental stresses, and (4) Develop improved methods for control and management of pests.

Research on this SRP is accomplished in 21 parent NRP's and 2 related SRP's. The parent NRP's include one on plant germplasm, 11 on commodities or groups of commodities, one on basic science, and seven on pest control programs. The purpose of this SRP is to make visible and give emphasis to the common concern of these diverse research programs for reducing genetic vulnerability. The desired consequences are research programs "leading to efficient production of high quality crops, well adapted to our environment and cultural practices, and so protected against pests and environmental stresses that losses would be held to a minimum. The probability of catastrophic epidemics would be reduced and the ability to recover quickly from any epidemics that might occur would be enhanced."

4. Details of progress should be reported in the parent NRP's; however, overview highlights will be mentioned in this report.

The National Plant Genetics Resources Board was appointed by the Secretary of Agriculture in July 1975. This Board is not a part of this SRP; however, the objectives of the Board are so similar to those of the SRP, that its activities are relevant in this report. The Board met twice in 1976 and (1) called for status reports on the germplasm situation in 14 crops, (2) set in motion a process to identify committees of experts in crops or groups of crops to advise it on germplasm collection, maintenance, and utilization, (3) began writing an interim set of statements and recommendations for presentation to the Secretary early in 1977, (4) established a liaison with the International Board of Plant Genetic Resources.

Progress was made toward perfecting the National Plant Germplasm System. Highlights include: (1) granting contract to the Taximetrics Laboratory, University of Colorado, to work with Data Systems Applications Division of ARS to interview keepers and users of germplasm

and develop a report of the pros and cons of several alternative plans for storing and retrieving information on germplasm, (2) supporting eight germplasm expeditions to collect tomatoes, grapes, grasses, sugarcane, citrus, strawberries, pecans, (3) recommending nine collection expeditions for 1977, (4) authorizing construction of new seed storage facilities at the Regional Plant Introduction Station at Pullman, Washington, (5) identifying curators of germplasm, (6) developing plans for a national fruit and nut crop repository system, and (7) advancing the understanding of who are "official" curators of germplasm.

The national program to utilize plant genetic resources includes taxonomy, cytology, biochemistry, screening for useful characters, genetics of characters, developmental breeding to assemble combinations of useful characters, applied breeding, and release of improved breeding stocks and cultivars. The relationship of these activities to reducing the genetic vulnerability of crops rests on the assumption that the best defense is genetic diversity; not just genetic diversity between and within cultivars in production, but a reserve of genetic diversity reaching back through the system from cultivar to wild relatives of cultivated forms. The idea is to establish a uninterrupted gene flow from a base of wide genetic diversity ultimately resulting in improved cultivars. ARS has a genetics and breeding effort of about 207 SY. The constant official releasing of elite germplasm, parental lines, and cultivars is evidence the system is yielding the desired results. It is this traditional approach that is the backbone of genetic advances for improved production efficiency.

7. Locations involved include Beltsville, MD; Glen Dale, MD; Pullman, WA; Ames, IO; Geneva, NY; Experiment, GA; Fort Collins, CO; University Park, PA; Orono, ME; Ithaca, NY; Peoria, IL; Lafayette, IN; Delaware, OH; Wooster, OH; Urbana, IL; Columbia, MO; St. Paul, MN; Ankeny, IA; Madison, WI; East Lansing, MI; Fargo, ND; Mandan, ND; Brookings, SD; Palmer, AK; Lincoln, NE; Manhattan, KS; Fresno, CA; Shafter, CA; Salinas, CA; Davis, CA; Reno, NV; Brawley, CA; Honolulu, HI; Tucson, AZ; Las Cruces, NM; Phoenix, AZ; Logan, UT; Aberdeen, ID; Bozeman, MT; Prosser, WA; Corvallis, OR; Brownsville, TX; Beaumont, TX; Temple, TX; College Station, TX; Brownwood, TX; El Paso, TX; Lubbock, TX; Vernon, TX; Woodward, OK; Stillwater, OK; Stoneville, MS; Meridian, MS; Stuttgart, AR; Crowley, LA; Houma, LA; Mississippi State, MS; Auburn, AL; Gainesville, FL; Orlando, FL; Canal Point, FL; Miami, FL; Mayaguez, PR; Rio Piedras, PR; Tifton, GA; Savannah, GA; Byron, GA; Clemson, SC; Florence, SC; Charleston, SC; Raleigh, NC; Oxford, NC; Greenville, TN; Lexington, KY; Blacksburg, VA; Suffolk, VA; and National Arboretum, Washington, DC.

